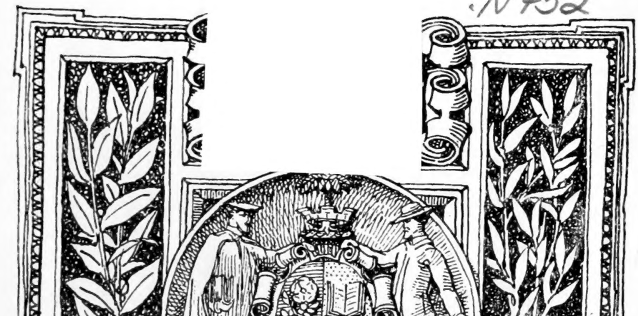
PRO SCIENTIA
SALUTE
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Cornell University — Agricultural Experiment Station.

FOURTEENTH ANNUAL REPORT

OF THE

CORNELL UNIVERSITY

Agricultural Experiment Station,

ITHACA, N. Y.

1901.

TRANSMITTED TO THE LEGISLATURE JANUARY 13, 1902.

ALBANY:
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1902.

STATE OF NEW YORK.

No. 59.

IN ASSEMBLY,

JANUARY 13, 1902.

FOURTEENTH ANNUAL REPORT

OF THE

Agricultural Experiment Station of Cornell University.

STATE OF NEW YORK:

DEPARTMENT OF AGRICULTURE,

ALBANY, *January* 13, 1902.

To the Honorable, the Legislature of the State of New York:

In accordance with the provisions of the statutes relating thereto, I have the honor to herewith transmit the Fourteenth Annual Report of the Agricultural Experiment Station at Cornell University.

CHARLES A. WIETING,

Commissioner of Agriculture.

ORGANIZATION

Of the Cornell University Agl. Exp. Station.

BOARD OF CONTROL

THE TRUSTEES OF THE UNIVERSITY.

THE AGRICULTURAL COLLEGE AND STATION COUNCIL.

STATION AND UNIVERSITY EXTENSION STAFF.

OFFICERS OF THE STATION.

Office of the Director, 20 Morrill Hall.

The regular bulletins of the Station are sent free to persons residing in New York State who request them.

REPORT.

ITHACA, N. Y.

To His Excellency, the Secretary of the Treasury,
Washington, D. C.

To His Excellency, the Secretary of Agriculture,
Washington, D. C.

To His Excellency, the Governor of the State of New York,
Albany, N. Y.

To His Excellency, the Commissioner of Agriculture,
of the State of New York:

SIR.— I have the honor to transmit herewith the fourteenth annual report of the Agricultural Experiment Station of Cornell University, in accordance with the Act of Congress of March 2, 1887, establishing the Station.

This document contains the report of the Director and the special reports of his scientific coadjutors, as well as copies of the bulletins, Nos. 183–193 inclusive, the Nature Study Quarterlies, Nos. 6–9 inclusive, Reading-Lessons for Farmers, Nos. 11–15 inclusive, and the Junior Naturalist Monthlies, Nos. 9 of Vol. II to 4 of Vol. III inclusive, and Reading-Lessons for Farmers' Wives, Nos. 1 and 2, all of which have been published by the Station during the year, and a detailed statement of the receipts and expenditures. With No. 9 above mentioned the publication of the Nature Study Quarterlies was suspended.

To the increased scope and effectiveness of the Experiment Station of Cornell University, due to the appropriations with which in recent years the Legislature of the State of New York has supplemented the annual appropriation from the Federal treasury I have already called attention in transmitting the thirteenth report. I would now also call attention to the fact that the farmers are coöperating with the

laboratory investigators in the most friendly and intelligent way, a fact which testifies strongly to the recognized utility of the investigations of the Station.

I have the honor to be your obedient servant,

J. G. SCHURMAN,

President of Cornell University.

REPORT OF THE DIRECTOR.

To the President of Cornell University:

SIR.—I have the honor to transmit herewith the fourteenth annual report of the Agricultural Experiment Station of Cornell University:

The $13,500 annually appropriated to the Station by the Federal Government has been supplemented by a portion of the State appropriation of $35,000 for the promotion of agricultural knowledge throughout the State. A part of this State appropriation is used for carrying on coöperative experiments and investigations on several hundred farms situated in various counties, while the Federal appropriation is all expended at the University in scientific and field investigations.

No striking discoveries have been made during the year, but many valuable facts have been added to our knowledge of the laws and forces which dominate the profession of the farmer. The field work among the farmers gives abundant material for work in the scientific departments and it also furnishes opportunity to test in the field the results secured in the laboratories. The hearty coöperation of the professors in the laboratories and the farmers in the fields furnish ideal conditions for securing workable scientific data.

It will give you pleasure to learn that the farmers are coöperating with us in a most friendly and intelligent way. There has been such a marked improvement in this respect since we have coöperated with the farmer at his home as to justify me in the belief that our methods of conducting investigations are at least good if not superior. I believe that during the last year we have done more toward the promotion of agricultural knowledge and research than in any other year since the Station has been established.

The Farmers' Reading Course assists us materially in securing intelligent, self-sacrificing and progressive investigators.

The climate and soil are so different in the various counties of the State that results reached at the home farm are not always applicable under changed conditions of soil and climate. On the other hand, the knowledge of facts secured by research in the laboratories is usually applicable in all parts of the State.

The reports of the heads of the various departments and subdepartments give briefly the chief lines of work completed and some of the larger undertakings now well under way.

Since the work of Investigation and University Extension Work for the promotion of agricultural knowledge are so closely correlated, I append a list of all the publications of these two bureaus of the College of Agriculture for the year ending June 30, 1901.

EXPERIMENT STATION BULLETINS.

No. 183. "Sugar Beet Pulp as a Food for Cows."

No. 184. "The Grape Root-Worm; New Grape Pest in New York."

No. 185. "The Common European Praying Mantis; A New Beneficial Insect in America."

No. 186. "The Sterile Fungus Rhizoctonia."

No. 187. "The Palmer Worm."

No. 188. "Spray Calendar."

No. 189. "Oswego Strawberries."

No. 190. "Three Unusual Strawberry Pests and a Greenhouse Pest."

No. 191. "Tillage Experiments with Potatoes."

No. 192. "Further Experiments against the Peach Tree Borer."

No. 193. "Shade Tree and Timber Destroying Fungi."

CORNELL NATURE STUDY QUARTERLY.

No. 6. Oct., 1900. "How Plants Live Together."

No. 7. Jan., 1901. "A Hill of Potatoes."

No. 8. Jan., 1901. "A Study of Fishes."

No. 9. May, 1901. "Spiders."

HOME NATURE STUDY COURSE.

No. 9. Nov., 1900. "Witch Hazel" — "Galls."
No. 10. Jan., 1901. "Evergreens."
No. 11. Feb., 1901. "Trees."
No. 12. Mch. 1901. "Waiting for Spring."
No. 13. Apr., 1901. "April Showers."
No. 14. May, 1901. "Maples."
No. 15. June, 1901. "The Cabbage Butterfly."

JUNIOR NATURALIST MONTHLY.

No. 9, Vol. 2. Oct., 1900. "Autumn Leaves."
No. 10, Vol. 2. Nov., 1900. "A November Walk."
No. 11, Vol. 2. Dec., 1900. "The War Among the Trees."
No. 12, Vol. 2. Jan., 1901. "The Snow Storm."
No. 1, Vol. 3. Feb., 1901. "Winter Pruning."
No. 2, Vol. 3. Mch., 1901. "Robin — Polistes the Paper Maker."
No. 3, Vol. 3. Apr., 1901. "Something for Young Farmers."
No. 4, Vol. 3. May, 1901. "Field Acquaintances."

READING COURSE FOR FARMERS.

No. 10. Mch., 1901. "Soiling Crops and Silage."
No. 11. Nov., 1900. "A Tree."
No. 12. Dec.. 1900. "Orcharding — A Survey of the Preliminaries."
No. 13. Jan., 1901. "Orcharding — Management of the Orchard."
No. 14. Feb., 1901. "Orcharding — Care of the Tree."
No. 15. Mch., 1901. "Orcharding — Handling the Fruit."

READING COURSE FOR FARMERS' WIVES.

No. 1. Jan., 1901. "Saving Steps."
No. 2. Apr., 1901. "Home Sanitation."

REPORT OF THE TREASURER.

The Cornell University Agricultural Experiment Station,
In account with
The United States Appropriation, 1900–1901.

To Receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30, 1901, as per Act of Congress approved March 2, 1887		*Dr.* $13,500 00
	Cr.	
By Salaries	$8,936 77	
Labor	1,199 43	
Publications	1,468 23	
Postage and stationery	482 29	
Freight and express	90 24	
Heat, light, water and power	74 25	
Chemical supplies	101 46	
Seeds, plants and sundry supplies	491 35	
Fertilizers	6 75	
Feeding stuffs	42 83	
Library	66 79	
Tools, implements and machinery	21 58	
Furniture and fixtures	106 33	
Scientific apparatus	248 86	
Live stock	19 50	
Traveling expenses	117 15	
Contingent expenses	25 00	
Buildings and repairs	1 19	
Total		$13,500 00

(Signed) E. L. WILLIAMS,
Treasurer.

We, the undersigned, duly appointed Auditors of the Corporation do hereby certify that we have examined the books and accounts of the Cornell University Agricultural Experiment Station for the fiscal year ending June 30, 1901; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $13,500.00 and the corresponding disbursements $13,500.00; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance.

And we further certify that the expenditures have been solely for the purposes set forth in the Act of Congress approved March 2, 1887.

(Signed) HENRY B. LORD,

[SEAL] MYNDERSE VAN CLEEF,

Auditors.

Attest: EMMONS L. WILLIAMS,

Custodian.

REPORT OF THE CHEMIST.

To the Director of the Cornell University Agricultural Experiment Station:

Sir.— Nearly all of the work of the Chemical Division of the Federal Experiment Station for the year 1900–1901 has been done by the Assistant Chemist, Mr. G. W. Cavanaugh. The report is, therefore, made and signed by him.

Very respectfully yours,
G. C. CALDWELL.

To the Chemist of the Cornell University Agricultural Experiment Station:

Sir.— The following is a general account of the chemical analyses and the investigations which have been made during the past year.

One hundred and sixty-six samples of sugar beets have been analyzed and various by-products of the sugar factories have been examined. Special attention was given to the study of the quality of certain standard varieties. Analyses of twenty-six samples of soils with reference to the conservation of soil moisture have been made.

In response to numerous requests analyses of worn-out soils have been undertaken. While it is not expected that an analysis will of itself always show the means of restoring the fertility of such soils, it is believed that the results, if properly studied, may, in many cases, be very useful.

There has been an increased demand from different parts of the State for the examination of agricultural materials of more or less value. Under this head may be included thirty-six samples of fertilizers, feeds, soils, ashes, butter colors and insecticides.

Four cases have been submitted from the Veterinary College for toxicological examination, and have been analyzed.

Respectfully submitted,
G. W. CAVANAUGH.

REPORT OF THE BOTANIST.

To the Director of the Cornell University Agricultural Experiment Station:

Sir.—I herewith present the annual report of the Botanical Division for the past year, including an outline of the work in progress by myself and by Dr. B. M. Duggar, whose report in full is appended.

During the few years that Dr. Duggar has been connected with the Botanical Division, in order to economize the work I have left the investigation of plant diseases caused by the more minute forms of the fungi to him, while I have given my attention largely to the investigation of the diseases of timber, shade and fruit trees, caused by the larger fungi like the mushrooms and their allies; and to a study of the fleshy fungi for the purpose of accumulating information as to the edible and poisonous kinds which grow in the fields and woods.

Bulletin 193, recently issued, gives in detail the results of some of my studies on the wound parasites of trees. Four species are treated of, *Polyporus borealis* on coniferous trees, *Polyporus sulphureus* on oaks and other deciduous trees, *Polyporus pinicola* on conifers, and *Trametes abietis* on spruces. The observations have extended over a period of several years and trees have been examined which give quite a complete history of the entrance of the fungus into the tree, the spread of the mycelium and disorganization of the heart wood, and, finally, the advance of the mycelium from the heart wood outward into the living cambium which may result in the death of the tree.

After the tree is once infected there is no remedy. Possibly the destruction of the fruit bodies of the fungus would lessen the chances of the infection of healthy trees when they become wounded. But for the protection of fruit trees, shade or timber trees, sanitary measures must be resorted to to prevent wounds of such a character that invite the entrance of the fungus mycelium. Judicious

treatment and pruning of fruit and shade trees from the nursery to the field, and a careful forest system for the protection of young and old timber during lumbering operations, as well as protection from fire, and the avoidance of dense shade which shuts out the light from the young trees, must be resorted to if it is desired to lessen the great losses now resulting from the action of wound parasites.

In the study of the edible and poisonous species of mushrooms a great amount of information is being gathered. Several hundred photographs of various species have been made, and a critical study of the characteristics of the species which should enable us to better understand our fungus flora. The earlier descriptions of European as well as of American forms were in many cases so meagre as to lead to great confusion. The result is that many species have been renamed, some of them several times, and in a great many cases species have been wrongly determined.

This difficulty will exist for some time to come, and the conditions can only be improved by a thorough study of our plants. This must be made when the plants are in the fresh condition, and close attention must be given to minute structural characters which were overlooked by the majority of the older mycologists, and also are overlooked by many to-day.

The problem of the fleshy fungi is different from that of most other groups of plants, where the plants may be dried as soon as collected and then are suitable for study of the toxonomic characters years later. Many of the fleshy fungi dry poorly, and hence lose important characters. Some of these characters preserve well in alcohol, while other characters are lost. Bulletins 138 and 168 have demonstrated quite clearly that the camera is a most valuable means of recording certain specific and generic characters of these plants. These photographic records, combined with a study in the fresh condition of characters of form, color and minute structure, together with *well dried* specimens make the best records of those characters which it is desirable to have, though some forms will need to be preserved in alcohol and when possible duplicates of those which are dried might well be preserved also in alcohol.

To carefully collect and preserve these plants, therefore, entails vastly more labor than with most other groups and is correspond-

ingly more expensive. But if such a study could be wisely conducted on a large scale the result would be of great importance and would justify a large endowment fund for research on the mycologic flora of America.

In connection with my studies of the different species especial attention is being given to certain genera in which the best edible species occur, and also to those forms or varieties of the common mushroom, or closely related species, with a view to inquiring into the possibility of employing some of them in cultivation. This is a desirable field of work to prosecute, and some facilities should be provided which would make it possible to test some of these forms when they apppear. Respectfully submitted,

GEO. F. ATKINSON.

To the Botanist of the Cornell Agricultural Experiment Station:

SIR. — I transmit the following report for 1900–1901: — During the past year a variety of plant diseases have occupied the attention of the botanist working under the "Nixon appropriation." In conjunction with F. C. Stewart, botanist of the State Agl. Exp. Sta., Geneva, forms of the sterile fungus *Rhizoctonia* have been studied as a cause of various plant troubles in this State, and incidentally in other States. Bulletin 186 embraces some of the work along this line. The fungus has occupied our attention since 1898. The work is directed towards a monographic report, of which Bulletin 186 embodies only preliminary data. The occurrence of *Rhizoctonia* on some entirely new hosts has been observed, and also upon other hosts new to America. Among the economic plants upon which it has been found are the bean, *Phaseolus vulgaris;* sugar beet, *Beta vulgaris;* cabbage and cauliflower, *Brassica oleracea;* carrot, *Daucus carota;* celery, *Apium graveolens;* cotton, *Gossypium herbaceum;* lettuce, *Lactuca sativa;* potato, *Solanum tuberosum;* radish, *Raphanus sativus;* rhubarb, *Rheum rhaponticum;* ornamental asparagus, *Asparagus sprengeri;* China aster, *Callistephus hortensis;* carnation, *Dianthus caryophyllus;* sweet William, *Dianthus barbatus; Coreopsis lanceolata;* violet, *Viola odorata;* and also on white pine and cucumber seedlings; cuttings of begonia, coleus, verbena, hydrangea, hardy candytuft, mammoth sage; and

on mature plants of phlox, pyrethrum, snapdragon, raspberry, lamb's quarters, pigweed, and tumble weed. Field observations have been made upon these diseases so far as possible. The parasitism of the fungus has also been studied as much as time and the very limited greenhouse facilities at my disposal would permit. The work of "cross inoculations" must be extensively conducted. In addition, most of the various form of the fungus are being studied in laboratory culture. In general, Rhizoctonia is a damping-off fungus, and a cause of certain root and stem diseases of plants. It is usually to a considerable extent dependent upon moist conditions for its rapid spread and propagation. Effective means of prevention have not been found, except in the sterilization of greenhouse or potting soil in the case of choice plants.

An important disease of the currant in the Hudson Valley has received much attention, and five visits have been made to that region in order to study as far as possible the conditions governing that disease in the field, and the effects of it upon the host plant. The fungus has been isolated and studied in the laboratory, and numerous inoculation experiments have been made. This disease has hitherto received only the most casual attention, and no successful attempt has previously been conducted to determine the fungus causing it. A bulletin will shortly be issued setting forth the present state of our knowledge concerning this disease.

An inextensive survey of the hop diseases in the hop-growing section of the State, particularly at Waterville, has resulted in finding one very destructive malady. Immediately previous to the time of picking and harvesting the hops in this region, the vines in almost every yard were found to be more or less severely affected with a leaf fungus, a species of *Cylindrosporium*. This fungus attacks and injures the leaves first, and then its injuries extend to the hops themselves. When the leaves alone are affected, merely the general vigor of the vine is reduced; but when the hops are diseased, they turn brown, present a poor appearance and much bleaching is necessitated in order to render them marketable. Sometimes the fungus causes the hops to shatter so badly that they are almost worthless. A thorough study of the fungus diseases of the hop in this State would be very desirable.

In the vicinity of Rochester a new stem disease of the snapdragon has been found. Affected plants or branches first wilt, and then soon die. The fungus attacks the vascular system particularly. The organism causing this disease has been isolated and studied in the laboratory, and the disease repeatedly produced by the artificial infection of healthy plants with pure cultures. Apparently, the fungus may only gain entrance where the stem is injured, or where it remains constantly moist; and soil inoculations have always given negative results.

Less important diseases of plums and apricots, pæonies, asters, and some other ornamental plants have received some attention.

In addition, during the summer of 1900 calls were received to make inspections of beet fields badly affected with leaf spot and of celery fields troubled with the late blight.

A blight of maple trees caused by the hot winds and by other injurious conditions was so prevalent in August, 1900, and demanded so much correspondence, that a circular letter explaining the disease was issued. Peach leaf curl was also very abundant and injurious during the past spring and necessitated considerable correspondence.

Some studies made by students taking work with me have yielded results which will have important bearing upon certain questions of economic interest in plant pathology and physiology. The results of this work have not been published, but it may be said that Dr. J. F. Clark has studied in detail the toxic action of many of the copper compounds upon the fungi, with special reference to Bordeaux mixture; and light has been thrown upon the method of action of this important fungicide. Dr. Margaret C. Ferguson has studied the physiology of the germination of mushroom spores. Her successful results with the germination of the spores of *Agaricus campestris*, the common mushroom, lead us to believe that soon we will be able to grow in pure culture, the mycelium, or spawn of this mushroom in a practical way. Previously the only successful studies in the germination of such spores have been made by certain French investigators, particularly at the Pasteur Institute, Paris, where the methods employed, unfortunately, are strictly secret.

Very respectfully submitted,

B. M. DUGGAR.

REPORT OF THE ENTOMOLOGIST.

To the Director of the Cornell Agricultural Experiment Station:

SIR.— As the Entomological work of the Station has been performed during the past year almost entirely by the Assistant Entomologist, I have requested him to prepare a report on it, which I herewith transmit.

Very respectfully yours,

J. H. COMSTOCK.

To the Entomologist of the Cornell University Agricultural Experiment Station:

SIR.— The past year has been an unusually busy and interesting one in the Entomological Division of the Station. Several insect pests committed depredations in the State for the first time, and a new beneficial insect was found to have established itself near Rochester. An increased correspondence resulting largely from the work done in the Bureau of Nature Study and Farmers' Reading Course, has occupied much of our time, but we feel that it is time well spent; special effort is made to reply to every query quickly and fully.

Hundreds of new and valuable pictures of insects and their work were made during the year, and the division is now well equipped with lantern slides, many of them colored from nature, for illustrating lectures on the economic and popular phases of our work; the Bureau of Nature Study often find these lantern slides very useful in their work.

So many new or unusual insect pests demanded our attention and other duties were so pressing that we have not yet prepared for publication our extensive investigations on canker-worms and the apple aphis, but we hope to do so during the coming year.

In September, a very serious pest was found to have invaded the

Chautauqua grape region, and the results of our observations on this new menace to this great New York industry were recorded in bulletin:

No. 184. "The Grape Root-Worm: A New Grape Pest in New York." 12 pages.

The most remarkable insect episode of the year was the discovery that one of those curious and interesting insects known as Praying Mantis had established itself and was breeding freely near Rochester. It was imported accidentally from Europe by nurserymen, and seems to have never before obtained a foot-hold on this continent. As we have no similar insect in New York and as its diet consists of other insects, many of them injurious ones, it is an interesting and valuable addition to the insect fauna of our State. Some of the children of Rochester collected hundreds of the curious egg-clusters of this Praying Mantis for us in the spring, and we distributed them in various sections of New York and to the entomologists of several other States, hoping thereby to establish this beneficial insect in other localities. A much larger Oriental species of Praying Mantis was imported into Pennsylvania some years ago, and many of its eggs which we recently distributed about Ithaca are now hatching; thus the indications are that another of these interesting beneficial insects will be able to breed in our State. It gave us much pleasure to announce the advent of so interesting an insect, with illustrations from life; our observations on the European Mantis were published in bulletin:

No. 185. "The Common European Praying Mantis: A New Beneficial Insect in America." 13 pages, limited edition.

In June many fruit-growers in Central and Western New York suddenly discovered that what was apparently a new insect pest was seriously injuring the foliage and young fruits on their trees. It proved to be the palmer-worm, an insect which had not appeared in injurious numbers in half a century. We studied its life and habits in detail, and our investigations were published in bulletin:

No. 187. "The Palmer-worm." 21 pages.

A leaf-rolling caterpillar which had never been reported as injurious in New York did considerable damage to strawberries in Chautauqua county, and we succeeded in learning its life-history.

Our attention was also directed to two other insects which seemed to have recently acquired a liking for strawberries. Our investigation of these three pests, and of the greenhouse leaf-tyer, one of the most annoying of greenhouse pests, were recorded in bulletin :

No. 190. "Three Unusual Strawberry Pests and a Greenhouse Pest." 20 pages.

Finally, we devoted considerable time to making further tests of some remedial measures suggested for combating the peach-tree borer. The results were quite different from what we had been led to expect, and hence were deemed of sufficient importance to be recorded in a brief bulletin :

No. 192. "Further Experiments Against the Peach-tree Borer." 6 pages.

Respectfully submitted,

M. V. SLINGERLAND.

REPORT OF DAIRY HUSBANDRY.

To the Director of the Cornell University Agricultural Experiment Station:

SIR.— The work of the Division of Animal Industry and Dairy Husbandry has progressed along the same general lines during the past year as heretofore. Some important work in feeding cows has been inaugurated and is progressing satisfactorily; but will require about two years more for completion. The supervision of weekly records of thoroughbred cows for their owners has continued to be an important part of the work of this division and is furnishing a large mass of data that will be available in the future. As the expense of this work is borne by the owners of the cattle the energies of the Station are not crippled by it and at the same time an opportunity is given for widening the influence of the Station among a class of progressive farmers.

A series of experiments in Poultry culture have been outlined and it is hoped they may be carried out during the coming winter.

In conclusion I wish to acknowledge the very faithful and efficient services of the Assistant in this department, Mr. Jas. A. Foord.

Respectfully submitted,

HENRY H. WING,

Assistant Professor of Animal Industry and Dairy Husbandry.

REPORT OF THE AGRICULTURIST.

To the Director of the Cornell University Agricultural Experiment Station:

SIR.— The work of the Agricultural Division of this Station during the past year has been long the following general lines:

Tillage and spraying experiments with potatoes.

Variety tests of sugar beets.

Variety tests of wheat.

Fertilizer and variety tests of buckwheat.

Soil renovation,

Grass and forage culture.

Feeding experiments with pigs and sheep.

Some of the lines of work mentioned above have been in progress for several years, and yet their importance seems to demand that the work be continued. Four bulletins have been published giving the results of experiments with potatoes, yet the continuation of the work is revealing something new each year, and emphasizing results already obtained. We have at the present time twenty-three one-twentieth acre plats upon the University farm devoted to potatoes. Under the University extension work in charge of Mr. J. L. Stone, one hundred twenty-eight farmers are conducting variety tests of potatoes, the seed tubers for which were furnished by the College of Agriculture. Where reports have been received from those who have adopted the methods recommended by this Station the results have in nearly every case been satisfactory.

In coöperation with the U. S. Department of Agriculture we are growing one plat of sugar beets, variety Dippe's German Kleinwanzlebner Elite, No. 5,772. In addition to the above mentioned variety of sugar beets we are making tests of the following varieties of sugar beets: Fredereickswether elite, Strandes Kleinwanzlebner, Dippes Kleinwanzlebner, Vilmorin, Utah grown, and Hoerning's

German Kleinwanzlebner. That sugar beets can be grown in this State with profit has been amply demonstrated. We believe it was largely due to experiments conducted by this Station that the farmers of the State were induced to undertake the culture of sugar beets. We shall make tests of leading varieties each year so that we may keep in touch with the beet growing industry in the State.

For the past eight years we have tested each year some six or more of the leading varieties of wheat. Each year we have thrown out the varieties which seemed least promising, retaining the best and securing in part new varieties for the next year. The experiments have been conducted in the regular farm wheat field under field conditions. In the fall of 1900 several varieties of wheat were sent by Mr. Stone to each of nine farmers located in various sections of the State. As a result of the experiments upon the home grounds and the coöperation experiments during the past year we have found that while the wheat throughout the State has been very generally injured and in some cases completely destroyed by the Hessian fly, the variety Dawson's Golden Chaff has withstood the attacks and in all the tests has produced well. A bulletin giving observations upon wheat varieties and their ability to withstand the attacks of the Hessian fly is now in press. Buckwheat is one of the standard crops of this State, and yet no investigations have been made to determine the best variety, or the conditions favorable to the crop. We have secured nearly three acres of land on a farm some two miles from the University and are conducting experiments upon twenty-five plats. In addition some ten or fifteen farmers are conducting variety tests and making observations on buckwheat. We hope to continue these experiments through a series of years until we shall have learned something definite about the crop and of its effect upon soils.

Some fourteen plats are being devoted to soil renovation work. Part of these plats are located upon the University farm, and part upon a farm some three miles away. The object sought is to determine the best rotation and the best cover crops to use with and without commercial fertilizers, for the improvement of depleted soils, and at the same time remove a crop from the land each year. This work of necessity is slow in giving results, but eventually

results of importance are certain. The aim of this division is to secure results which will prove of practical benefit to the farmer, as well as to discover truths and establish principles. In carrying out these plans there has been thorough coöperation in the experiments conducted throughout the State by Mr. J. L. Stone, and those conducted on the home grounds.

Respectfully submitted,

L. A. CLINTON.

REPORT OF THE HORTICULTURIST.

To the Director of the Cornell University Agricultural Experiment Station:

SIR.—The work in the Horticultural Division of the Experiment Station during the year 1900–1 has proceeded along the accustomed lines. Particular effort has been given to the forcing of strawberries and the tree fruits. With strawberries excellent results have been secured, but with the tree fruits the results have been somewhat indifferent, owing to the unsatisfactory houses in which the work is done. Studies of mushroom growing are also in progress. The land of the Horticultural Division is largely taken up with the orchards, which are now coming into full bearing. These orchards are all experimental in the sense that the effects of pruning, tillage, fertilizing, cover-cropping and general treatment are under observation. On these and other subjects, reports are to be made from time to time. A rather large collection of grapes has been planted, and many of the varieties are now coming into bearing. The collection of Japanese plums is very large, and is increasing as fast as new varieties appear. It is the purpose to give particular attention to these fruits, since we have already studied them with considerable care. Many special subjects have been taken up for study during the year, such as the influence of various conditions on the viability of pollen; investigations in methods of spraying, considering various mixtures and the enemies to be combated; a study of the botanical and horticultural status of the garden tulips; tests of geraniums, and other incidental matters. Some of these subjects have been in charge of special advanced students. Considerable work is also being done by the Horticultural Division in places outside of Ithaca in the treatment of orchard lands, spraying of trees when in bloom, and other problems. For the most efficient work at Ithaca, more glass houses are much needed.

Respectfully submitted,

L. H. BAILEY.

REPORT OF THE HORTICULTURAL EXPERIMENTS IN PROGRESS UNDER DIRECTION OF EXTENSION DEPARTMENT.

To the Director of the Cornell University Agricultural Experiment Station:

SIR.— In prosecuting the correspondence courses in agriculture I have found it desirable to continue as collateral work the illustrative experiments instituted by yourself and the Professor of Horticulture. These experiments are carried on coöperatively by the College and the farmer under the State "Nixon appropriation." They form points of contact and create bonds of sympathy between the farmer and the scientific investigator and as such are of great value in extending the influence of the University and Experiment Station.

The investigations in progress this year follow six lines.

1. Renovation of apple orchards.
2. Trial of orchard cover crops.
3. Spraying of fruit trees when in blossom.
4. The cabbage industry.
5. Garden beans.
6. Musk melons in Western New York.

1. The experience of the past five years demonstrates that the well cared for apple orchard is valuable property in the greater part of New York State. Many orchards have been neglected and have become unproductive. Will it pay to invest money in renovating them? In the majority of cases, yes. Tillage, fertilizers, spraying and pruning will usually restore them to a revenue producing basis in from three to five years. Experiments corroborating this statement are in progress.

2. Fruit-growers are constantly urged to use cover crops in their orchards for the purpose of maintaining fertility. What best kinds

are, how and when they should be sown, are subjects under investigation with the assistance of many orchardists of the State.

3. The advantages and disadvantages of spraying fruit trees in bloom have again been investigated. The evidence secured this year justifies us in pronouncing strongly against the practice. Spraying fruit trees in bloom lessens the set of fruit. When trees bloom heavily, one or even two sprayings may work no injury, but when the bloom is light, injury is certain to result. Cherries, plums and pears sprayed every day during the blossoming period set no fruit. Apple trees sprayed every day set very sparsely, while others of the same variety and in similar condition, not sprayed, set well.

4. The cabbage industry of the State is being investigated in view of its rapidly increasing importance.

5. An investigation of the cultivated types of the garden beans taken up some years ago is being continued this season.

6. During the past five years the area devoted to the culture of musk melons in Western and Central New York has greatly increased. The importance of the industry has suggested coöperative experiments which are being carried on.

It is hoped that reports embodying the results of these several lines of investigations will be published during the year.

Respectfully submitted,

JOHN CRAIG,

Professor of University Extension Teaching in Agriculture and Horticulture and

Supervisor of the Farmers' Reading Course.

APPENDIX I.

BULLETINS PUBLISHED JUNE 30, 1900, TO JULY 1, 1901.

No. 183. Sugar Beet Pulp as a Food for Cows.

No. 184. The Grape Root-Worm; New Grape Pest in New York.

No. 185. The Common European Praying Mantis; A New Beneficial Insect in America.

No. 186. The Sterile Fungus Rhizoctonia.

No. 187. The Palmer Worm.

No. 188. Spray Calendar.

No. 189. Oswego Strawberries.

No. 190. Three Unusual Strawberry Pests and a Greenhouse Pest.

No. 191. Tillage Experiments with Potatoes.

No. 192. Further Experiments against the Peach Tree Borer.

No. 193. Shade Tree and Timber Destroying Fungi.

Bulletin 183. September, 1900.

Cornell University Agricultural Experiment Station.

ITHACA, N. Y.

DAIRY DIVISION.

SUGAR BEET PULP

AS A

FOOD FOR COWS

By HENRY H. WING and LEROY ANDERSON.

PUBLISHED BY THE UNIVERSITY,

ITHACA, N. Y.

1900.

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SUGAR BEET PULP AS A FOOD FOR COWS.

The cultivation of the sugar beet and its subsequent manufacture into sugar has left upon the hands of the manufacturer a large mass of material which causes more or less inconvenience because of its great bulk, and the consequent difficulty of readily and cheaply disposing of it. This material is commonly known as beet pulp. It comes from the sugar factory through an operation which is briefly as follows: As soon as the beets are washed they pass through a knife bearing machine which cuts them up into small round strips about the size of wool-twine. The beets thus cut are then placed in large upright cylinders through which hot water is forced and the sugar thereby dissolved out of the beets. After the sugar has been carried off in solution by the water, the remaining portion of the beets (called beet pulp or residue) is of no further use to the manufacturer and is carried away to any convenient dumping ground. In passing through such a soaking process it will be readily imagined that the residue contains a large amount of water unless the water in some manner be pressed out. As a matter of fact, some of the water is taken out but so much remains that beet pulp as we obtain it contains ninety per cent or more of water.

Whether the beet residue containing so much water as it does on coming from the factory has any feeding value, is a question which the sugar manufacturer wishes solved before he can dispose of it to cattle feeders or dairymen, and which the latter desire some light upon before they purchase it in large quantities. In the continental countries of Europe where the beet sugar industry has attained large proportions, and where there is a greater scarcity of fodder than in America, beet pulp is largely used in feeding animals, and various means have been resorted to to preserve it for such purpose. Sometimes it is thoroughly pressed and dried. It may be fed in

this form or mixed with refuse beet molasses or other refuse feeding materials before finding its way to feeding stables. Again, it has been preserved in silos with good results. Several references to the feeding of beet pulp under these various conditions may be found in Bulletin No. 173 of this station.

The first attempt of this experiment station to ascertain the feeding value of sugar beet residue was made in the fall of 1897, when a few barrels of the material were received from the First New York Beet Sugar Co., of Rome, N. Y. The amount of pulp fed was so small that the results obtained did not warrant their publication. Early in December of the following year a carload of fresh pulp was secured from the Binghamton Beet Sugar Co., of Binghamton, N. Y., and immediately a feeding trial was begun and continued through some ten weeks with five cows. In the fall of 1899 another trial was made of the beet pulp by feeding it to six of the University cows for a period of seven weeks. The pulp used at this time was also obtained in car lots from the Binghamton Beet Sugar Co.

Analyses of the pulp at various intervals showed it to contain from 91 to 93 per cent of water. A complete chemical analysis made by Mr. G. W. Cavanaugh, assistant chemist of the Station, is here given, together with the average composition of corn silage as given in Bulletin No. 11 of the Office of Experiment Stations, compiled by Jenkins and Winton.

	Beet pulp.	Corn silage.
Water	91.68	79.1
Crude protein	.57	1.7
Crude fibre	1.86	6.0
Nitrogen free extract	5.38	11.1
Ether extract	.09	.8
Ash	.42	1.4

A test of the beet pulp showed that the nitrogen free extract contained only traces of sugar.

As a rule the cows ate the pulp with a great relish. The one exception to this in our experiments was Mollie during the season 1898–9. At first she refused it almost entirely and it was not until the fifth week that she would eat 50 pounds per day. In beginning

to feed beet pulp it is best to give small quantities at first and increase the amount gradually as the cow's appetite permits.

THE FIRST EXPERIMENT 1898–99.

The plan of this experiment was to feed the beet pulp in alternating periods with corn silage, and to feed about the same amount of pulp daily as of silage to the individual cows. Because of the greater amount of dry matter in silage this resulted in the smaller cows consuming twice as much hay when fed pulp as when on silage and with the further result that practically equal amounts of dry matter were consumed whether the cow ate silage or pulp.

The grain fed consisted of eight pounds per head daily of a mixture composed of two parts of gluten feed, two parts of wheat bran and one part of cotton seed meal. The milk was weighed at each milking and composite samples taken which were tested for fat content each week. A description of the cows as to breed, age, number of days in milk and weight follows:

	Age.	No. of days in milk.	Weight beginning.	Weight end.
Ada, 31-32 Holstein	2	57	920	950
Cherry, Grade Jersey	5	Calved Dec. 12	900	910
Kate, 7-8 Holstein	2	81	900	960
Mollie, 15-16 Holstein	9	88	1,250	1,280
Ruby, 3-4 Holstein	10	194	1,300	1,308

The weekly record of each of these cows as to the amounts of different foods consumed and of milk and fat produced together with the dry matter consumed per 1,000 pounds daily and the number of pounds of dry matter required by each to produce one hundred pounds of milk and one pound of fat is found in table I. The experiment began on December 6, but the first five days were considered preliminary and the records as given in the table begin with December 11.

TABLE I.

INDIVIDUAL WEEKLY RECORDS OF FOOD CONSUMED AND OF MILK AND FAT PRODUCED.

Ada.

WEEK.	Food, pounds.				Pounds of milk.	Per cent fat.	Pounds of fat.	Dry matter required.		
	Silage.	Beet pulp.	Hay.	Grain.				Per 1,000 lbs. daily.	Per 100 lbs. milk.	Per 1 lb. fat.
1.....	280	......	42	56	134.3	3.80	5.10	22.5	107.9	28.4
2.....	278	......	30	56	132.8	3.90	5.18	20.9	101.4	26.0
3.....	280	......	23	56	125.8	3.75	4.72	20.0	102.0	27.2
4.....	280	......	31	56	135.8	3.90	5.29	21.1	100.0	25.7
5.....	280	......	29	56	132.0	3.90	5.15	20.6	101.8	26.1
6.....	40	220	49	56	135.8	3.60	4.89	18.1	87.0	24.2
7.....	......	280	69	56	132.5	3.55	4.70	20.3	100.0	28.1
8.....	......	280	70	56	133.8	3.20	4.28	20.2	100.0	31.1
9.....	......	315	70	56	130.0	3.20	4.16	20.6	104.5	32.6
10.....	175	90	39	56	118.3	3.50	4.14	19.3	108.3	30.9
11.....	245	......	36	56	122.5	3.50	4.29	20.0	108.6	31.0

Cherry.

2.....	245	......	27	30	159.5	5.55	8.85	16.2	63.8	11.4
3.....	245	......	31	56	169.8	5.60	9.51	20.4	75.7	13.5
4.....	245	......	37	56	183.0	5.70	10.43	21.2	73.1	12.8
5.....	245	......	43	56	194.0	5.80	11.25	22.0	71.3	12.3
6.....	40	220	56	56	194.3	5.60	10.88	19.8	64.1	11.4
7.....	......	280	69	56	193.5	5.90	11.42	21.0	68.3	11.6
8.....	......	280	66	56	188.5	5.80	10.93	20.6	68.7	11.9
9.....	......	315	70	56	178.3	5.55	9.89	21.5	76.2	13.7
10.....	175	90	49	56	180.5	5.80	10.47	21.4	75.6	13.0
11.....	245	......	40	56	173.0	5.30	9.17	21.4	78.9	14.9

Ruby.

1.....	346	......	82	56	256.3	3.15	8.07	21.2	75.5	24.0
2.....	333	......	77	56	243.8	3.25	8.22	20.4	76.3	22.6
3.....	346	......	71	56	238.3	3.10	7.39	20.2	77.3	24.9
4.....	350	......	83	56	242.3	3.20	7.75	21.4	80.6	25.2
5.....	350	......	82	56	236.5	3.35	7.92	21.3	82.2	24.5
6.....	60	250	84	56	227.0	3.30	7.49	17.1	68.4	20.7
7.....	......	350	85	56	227.8	2.90	6.60	16.6	66.5	23.0
8.....	......	350	84	56	218.0	3.35	7.30	16.5	69.1	20.6
9.....	......	385	84	56	214.0	3.25	6.96	16.9	71.7	22.0
10.....	240	110	74	56	196.8	3.70	7.28	19.0	88.0	23.8
11.....	350	......	69	56	217.5	3.40	7.40	19.7	82.9	24.4

TABLE I — *Continued.*

Kate.

WEEK.	Food, pounds. Silage.	Beet pulp.	Hay.	Grain.	Pounds of milk.	Per cent fat.	Pounds of fat.	Dry matter required. Per 1,000 lbs. daily.	Per 100 lbs. milk.	Per 1 lb. fat.
1.....	......	340	76	56	135.3	3.30	4.46	22.7	105.7	32.1
2.....	......	350	67	56	131.5	3.35	4.41	21.5	103.1	30.7
3.	......	350	67	56	127.0	3.20	4.06	21.5	106.8	33.4
4.....	......	350	66	56	133.0	3.15	4.19	21.5	101.7	32.3
5.....	.....	350	67	56	127.3	3.35	4.26	21.5	106.6	31.8
6.....	275	......	45	56	124.8	3.40	4.24	22.8	117.3	34.5
7.....	280	......	33	56	132.3	3.80	5.03	21.1	104.0	27.4
8.....	280	......	34	56	127.0	3.50	4.45	21.0	109.0	31.1
9.....	280	......	28	56	129.0	3.40	4.39	20.0	103.0	30.3
10.....	280	......	30	56	123.8	3.50	4.33	20.1	109.1	31.2
11.....	280	......	30	56	126.3	3.50	4.42	20.1	106.9	30.5

Mollie.

1.....	122	242	98	56	225.8	3.10	7.00	20.5	79.4	25.6
2.....	30	165	96	56	224.3	3.20	7.18	17.3	68.1	21.3
3.....	......	140	96	56	215.0	3.05	6.56	16.5	67.2	22.0
4....	......	185	98	56	230.5	3.25	7.49	17.1	64.8	20.0
5. ...	......	335	98	56	228.0	3.25	7.41	18.5	70.8	21.8
6.....	325	......	98	56	231.3	3.55	8.21	23.0	87.7	24.7
7.....	350	......	98	56	235.3	3.60	8.47	23.6	88.5	24.6
8.....	350	......	97	56	235.8	3.40	8.02	23.2	87.8	25.8
9.....	350	......	98	56	235.3	3.35	7.88	23.4	88.5	26.4
10.....	350	......	98	56	227.3	3.50	7.95	23.2	91.6	26.2
11. ...	350	......	98	56	228.3	3.45	7.87	23.2	91.2	26.5

THE SECOND EXPERIMENT 1899.

The plan of this experiment differs from that of the first in that the attempt was to feed the cows all the beet pulp they could readily consume and not give them any more hay than when they were on silage. The feeding of beet pulp began on October 14 when a portion of the silage was replaced by 20 pounds of pulp for each cow. This amount was gradually increased and the silage decreased until the latter was entirely replaced by beet pulp. The amount of pulp given varied according to the size and appetite of the animal.

Each one received 30 pounds at the morning feed, beside the hay allowance for the day and four pounds of grain. At night the quantity varied from 45 to 65 pounds and no other feed was given at this time except the remaining five pounds of grain. This grain ration was composed of a mixture of two parts of gluten feed, one part of sugar corn feed and one part of wheat bran.

Samples of each cow's milk were tested daily for fat by the Babcock test. The names of the cows used are given below together with their breed, age, number of days in milk and weight.

	Age.	No. of days in milk.	Weight beginning.	Weight end.
Ada, 31-32 Holstein	3	12	1,000	1,065
Belle, Jersey-Holstein	4	46	1,085	1,135
Bertha 2d, Grade Jersey	5	148	800	840
Garnet St. Lambert, 108,468 A. J. C. C.	4	46	855	915
Gilsta 4th, 31,408 H. F. H. B.	7	35	1,240	1,240
Ruby, 3-4 Holstein	11	161	1,270	1,370

The weekly record of each of these cows as to the amounts of different food consumed and of milk and fat produced, together with the dry matter consumed per 1,000 pounds daily and the number of pounds of dry matter required by each to produce one hundred pounds of milk and one pound of fat, is found in table II. These records begin with the week commencing October 13, although no beet pulp was fed until the day following.

TABLE II.

INDIVIDUAL WEEKLY RECORDS OF FOOD CONSUMED AND OF MILK AND FAT PRODUCED.

Ada.

WEEK.	Food, pounds. Silage.	Beet pulp.	Hay.	Grain.	Pounds of milk.	Per cent fat.	Pounds of fat.	Dry matter required. Per 1,000 lbs. daily.	Per 100 lbs. milk.	Per 1 lb. fat.
1.....	160	230	50	63	188.8	3.63	6.85	21.7	80.3	22.1
2.....	35	540	54	63	199.9	3.73	7.46	21.7	76.9	20.6
3.....	.....	630	56	63	187.9	3.65	6.86	21.8	82.6	22.6
4.....	.....	605	60	63	207.1	3.68	7.43	21.8	75.6	21.1
5.....	.....	630	56	63	202.9	3.61	7.32	21.3	76.5	21.2
6.....	.....	630	56	63	199.6	3.70	7.39	21.1	77.8	21.0
7.....	.....	630	56	63	182.4	3.79	6.91	20.9	85.3	22.5
8.....	250	30	55	63	192.7	3.55	6.84	21.4	82.4	23.2
9.....	245	.....	56	63	182.0	3.75	6.83	20.8	85.9	22.9
10.....	245	.....	56	63	182.4	3.65	6.66	20.8	85.6	23.5

Belle.

1.....	160	230	56	63	233.9	4.25	9.94	20.5	67.1	15.7
2.....	35	540	56	63	245.1	3.84	9.40	20.5	67.5	16.5
3.....	.....	630	56	63	226.1	3.97	8.98	20.4	68.7	16.5
4.....	.....	610	60	63	234.6	4.07	9.55	20.4	67.0	17.3
5.....	.....	595	56	63	225.8	3.83	8.65	19.6	67.6	17.6
6.....	.....	595	56	63	214.3	3.94	8.45	19.5	71.2	18.0
7.....	.....	595	56	63	217.4	3.94	8.57	19.3	70.1	17.8
8.....	250	30	51.5	63	202.8	4.03	8.17	20.1	78.3	19.4
9.....	245	.....	56	63	193.1	4.14	7.99	19.7	80.9	19.6
10.....	245	.....	56	63	197.2	4.04	7.96	19.7	78.7	19.6

Bertha 2d.

1.....	120	200	35	63	179.4	4.54	8.15	22.6	71.8	15.7
2.....	15	500	34	63	186.5	4.47	8.34	23.0	69.2	15.5
3.....	.....	560	38	63	185.3	4.47	8.29	23.7	72.4	16.2
4.....	....	530	53	63	182.9	4.35	7.95	25.2	79.1	18.2
5.....	....	525	49	63	167.0	4.35	7.27	24.2	84.3	19.4
6.....	.....	525	49	63	173.2	4.28	7.42	23.9	80.7	18.8
7.....	.....	525	49	63	169.5	4.68	7.93	23.7	83.1	17.8
8.....	225	30	49	63	160.2	4.59	7.36	25.1	92.7	20.2
9.....	205	.....	44.5	62	155.0	4.80	7.44	23.3	88.4	18.4
10.....	175	.....	42	56	150.9	4.76	7.19	21.0	81.7	17.1

TABLE II — *Continued.*

Garnet St. Lambert.

WEEK.	Food, pounds. Silage.	Beet pulp.	Hay.	Grain.	Pounds of milk.	Per cent fat.	Pounds of fat.	Dry matter required. Per 1,000 lbs. daily.	Per 100 lbs. milk.	Per 1 lb. fat.
1.....	120	225	35	63	180.2	4.63	8.34	21.7	72.1	15.6
2.....	15	475	33	63	185.2	4.44	8.22	20.6	66.5	15.0
3.....	......	560	38	63	192.2	4.37	8.39	22.3	69.9	16.0
4.....	.....	530	53	63	191.4	4.36	8.35	23.8	75.6	17.3
5.....	......	525	49	63	180.9	4.31	7.79	22.7	77.8	18.1
6.....	......	525	49	63	180.7	4.19	7.57	22.3	77.9	18.5
7.....	......	525	49	63	180.2	4.39	7.91	22.0	78.1	17.8
8.....	225	30	47.5	63	168.7	4.69	7.91	23.0	87.2	18.6
9.....	210	......	49	63	195.6	4.62	7.65	22.3	86.3	18.7
10.....	210	.....	49	63	166.9	4.60	7.68	22.3	85.6	18.6

Glista 4th.

1.....	200	230	80	63	297.0	3.48	10.34	21.4	62.6	17.9
2.....	50	540	84	63	308.8	3.45	10.66	21.0	59.1	17.1
3.....	....	630	84	63	308.2	3.20	9.86	20.7	58.1	18.2
4.....	......	645	90	63	304.2	3.50	10.64	21.3	61.0	17.5
5.....	....	630	84	63	281.8	3.44	9.68	20.5	63.6	18.5
6.....	......	630	84	63	281.6	3.44	9.66	20.5	63.7	18.6
7.....	......	630	84	63	277.1	3.44	9.54	20.5	64.7	18.8
8.....	......	30	84	63	258.8	3.40	8.81	21.9	73.9	21.7
9.....	285	......	84	63	263.3	3.48	9.17	21.6	71.2	20.5
10.....	280	......	84	63	276.7	3.27	9.05	21.6	67.8	20.7

Ruby.

1.....	200	230	80	63	213.1	3.53	7.52	20.9	86.8	24.6
2.....	50	540	84	63	236.2	3.34	7.88	20.5	77.3	23.2
3.....	......	630	84	63	229.8	3.37	7.74	20.0	78.0	23.2
4.....	......	645	79.5	63	181.8	3.58	6 50	19.4	97.2	27.2
5.....	......	630	84	63	188.3	3.54	6.66	19.5	95.2	26.9
6.....	....	630	84	63	198.9	3.37	6.71	19.3	90.1	26.7
7.....	......	630	84	63	172.9	3.15	5.44	19.1	103.7	33.0
8.....	285	30	80.5	63	168.0	3.27	5.50	19.9	112.0	34.2
9.....	280	......	84	63	157.3	3.29	5.17	19.7	119.3	36.3
10.....	280	......	84	63	163.0	3.03	4.94	19.6	115.2	38.0

Charts.

The following diagrams show the variation in average daily yield of milk and per cent of fat during the two feeding periods. The diagram for each cow is given above her name, the record for milk appearing above that for per cent of fat. Passing from left to right in the chart each division represents one week. Passing upward or downward each space represents one-half pound of milk or one-tenth of one per cent of fat as the case may be. The space between the heavy perpendicular lines represents the period during which beet pulp was fed, *i. e.*, in the year 1898–9; with Ada, Cherry and Ruby this period was from the sixth to the eighth weeks inclusive, while with Kate and Mollie it was from the first to the fourth weeks, inclusive. In the year 1899 the beet pulp feeding period was from the second to the sixth weeks, inclusive.

A survey of the records shows that the cows did quite as well on beet pulp as on silage. In fact the pulp seems to have had a stimulating effect on the flow of milk, as is seen from the records during the first few weeks of feeding pulp in 1899. With the exception of Mollie, 1898–9, and Ruby, 1899, the individual cows consumed about equal amounts of dry matter per 1,000 pounds live weight whatever the feed, and each one also required nearly the same quantities of dry matter for one hundred pounds of milk and one pound of fat, whether the food was silage or pulp. A greater difference in this respect is found in the amount of dry matter required for milk than of that required for fat, as may be shown by making a few averages from the records. In order to secure periods in which the peculiar influence of each food may be seen as clearly as possible, we have made up some averages from the third to the fifth weeks and from the seventh to the ninth weeks, inclusive, during the first experiment, and for the sixth and seventh and ninth and tenth weeks of the second experiment. The averages thus obtained are here given.

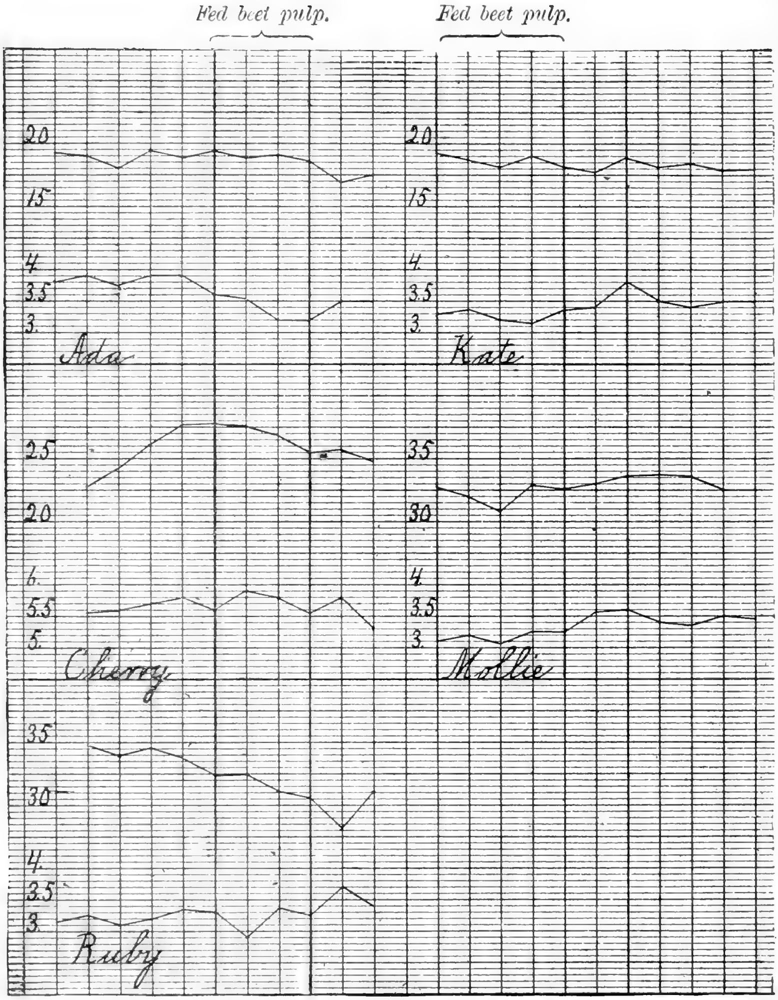

FIG. 1.— *Experiment of 1898–9. Each horizontal space represents one week. Each perpendicular space represents one-half pound of milk or one-tenth of one per cent of fat.*

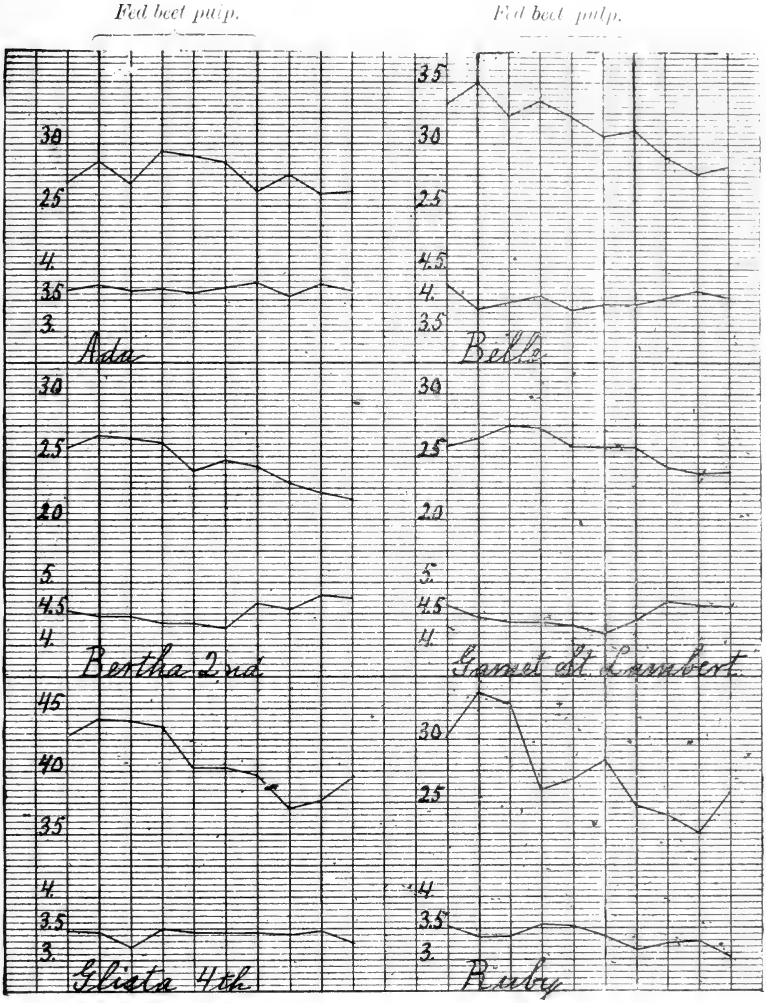

FIG. 2.— *Experiment of 1899. Each horizontal space represents one week. Each perpendicular space represents one-half pound of milk or one tenth of one per cent of fat.*

AVERAGE NUMBER OF POUNDS OF DRY MATTER REQUIRED TO PRODUCE 100 POUNDS OF MILK AND ONE POUND OF FAT.

YEAR.	No. cows.	No. of weeks in average.	Milk.		Fat.	
			Pulp.	Silage.	Pulp.	Silage.
1898-9	5	3	82.7	89.7	23.7	23.9
1899	6	2	78.9	87.2	20.8	22.8
Average of all			81.0	88.6	22.4	23.5

The fact has already been noted that during the first experiment when the amount of beet pulp fed to each cow was about equal in weight to the quantity of silage which she would normally eat, she consumed more hay than when fed silage. The records of the second experiment show that, when the cows were restricted as to quantity of hay and given all the beet pulp they desired, each one consumed daily more than twice the amount of pulp that she would normally require of silage. If, then the amounts of dry matter required to produce milk and fat do not differ materially whether the cows receive silage or beet pulp what is the relative feeding value of pulp as compared to silage? This may be determined by comparing the number of pounds of silage and beet pulp which were respectively required for equal amounts of milk or fat. The ratio of the one to the other will determine how much more one may be worth than the other to feed dairy cows. In finding this ratio the amounts of hay and grain need not be considered so long as equal quantities were consumed whether silage or beet pulp were fed as was the case in the second experiment with all the cows except Bertha 2d. In the first experiment the same quantities of grain were fed throughout, but since varying amounts of hay were fed this must be considered and has been so taken into account in making up the figures tabulated below. The ratios given were calculated from the individual records for the same periods as were used in determining the average amounts of dry matter required to produce milk and fat.

RATIO OF THE QUANTITY OF SILAGE TO THE QUANTITY OF BEET PULP REQUIRED TO PRODUCE EQUAL AMOUNTS OF MILK AND FAT.

1898–9.

	Milk.	Fat.
Ada	1:2.60	1:3.00
Cherry	1:2.16	1:2.14
Kate	1:2.64	1:2.90
Mollie	1:0.66	1:0.71
Ruby	1:1.21	1:1.23
Average	1:1.85	1:2.00

1899.

	Milk.	Fat.
Ada	1:2.46	1:2.42
Belle	1:2.20	1:2.28
Bertha 2d	1:2.70	1:2.90
Garnet St. Lambert	1:2.08	1:2.47
Glista 4th	1:2.16	1:2.14
Ruby	1:1.93	1:1.87
Average	1:2.26	1:2.35
Average of all	1:2.07	1:2.18

These figures show a considerable variation in the relative value of beet pulp and silage especially in the first experiment. But in this experiment the amount of hay fed was not constant, so that it would perhaps be fairer to draw our conclusions from the second experiment where the other constituents of the ration were constant and where the relation of the value of the two foods is much more uniform.

The low ratio given by Mollie is explained by the fact that she ate a comparatively small quantity of beet pulp. Although her average consumption of dry matter during the period of feeding pulp was about 17 pounds per 1,000 pounds live weight, still she managed to produce nearly as much milk as during a period of similar length when on silage and averaging over 23 pounds of dry matter per 1,000. This is a forcible illustration of a fact that has been frequently noticed, namely, that the ration of a well-nourished cow may often be considerably reduced for a period of some length without materially reducing the flow of milk. The average for eleven

cows gives silage slightly more than twice the feeding value pound for pound that is shown for beet pulp. In other words, if silage be worth two dollars per ton, which is an average price, then beet pulp would be worth about one dollar per ton.

If one desired to feed beet pulp during a whole season or during several months and were obliged to get it all at one time, some means of storage must be provided. Where not in contact with the atmosphere the pulp keeps well. But portions which are exposed for some time, as the top of the pile, decay to the depth of four or five inches. It would be best then to furnish air-tight storage as a silo, and to take the daily feeds from the top in the same way as is done with silage. The storage place should also be built so as to prevent freezing in the winter season.

It is probable, however, that most of the beet pulp will be fed out in the neighborhood of the beet sugar factories, either by dairymen who haul it in their own wagons or by those who may conveniently secure it in car lots, since the cost of long hauls by rail will not be compensated by returns from feeding. Accordingly, the problem of storage may not be so difficult of solution.

Since the beet sugar factories are in operation from about the first of October to January the pulp may be obtained fresh at a season of the year when pasturage is very short and green food scarce. It is therefore of considerable value in keeping up the flow of milk which is apt to decline rapidly in summer dairies, and in winter dairies it helps to start the cows on a full flow of milk. The dairyman may therefore save his silage for winter and spring feeding, by feeding beet pulp until winter sets in, and be assured that his cows will do quite as well as though the silo were opened earlier. Some hay or other coarse, dry fodder should be fed with beet pulp.

The effect of feeding beet pulp on the per cent of fat in the milk may be seen from the records not to be of definite importance. With some cows the milk was richer when they were fed silage than when fed beet pulp. With other cows there was no difference whether the feed was pulp or silage. Thus there seems to be no definite relation between the quality of milk and the food. There was no noticeable foreign odor or flavor in the milk from cows eating beet pulp.

CONCLUSIONS.

The cows, as a rule, ate beet pulp readily and consumed from 50 to 100 pounds per day, according to size, in addition to the usual feed of 8 pounds of grain and 6 to 12 pounds of hay.

The dry matter in beet pulp proved to be of equal value, pound for pound, with the dry matter in corn silage.

The milk producing value of beet pulp as it comes from the beet sugar factory is about one-half that of corn silage.

Beet pulp is especially valuable as a succulent food, and where no other such food is obtainable it may prove of greater comparative value than is given above.

Bulletin 184. **November, 1900.**

Cornell University Agricultural Experiment Station,

ITHACA, N. Y.

ENTOMOLOGICAL DIVISION

THE GRAPE ROOT--WORM

A NEW GRAPE PEST IN NEW YORK.

By M. V. SLINGERLAND.

PUBLISHED BY THE UNIVERSITY,

ITHACA, N. Y.

1900.

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CORNELL UNIVERSITY,
ITHACA, N. Y., *Nov.* 11, 1900.

Honorable Commissioner of Agriculture, Albany:

SIR.— The following report on "The Grape Root-Worm" contains the results of investigations made by Professor M. V. Slingerland of an insect pest new to New York grape-growers which has recently appeared in injurious numbers in some of the vineyards in the great Chautauqua grape region. Apparently the insect has never before been recorded as injurious to New York vines. It is to be hoped that its ravages in our State may be limited, for it is the most serious and dangerous insect enemy which has yet made its appearance in our vineyards; as it feeds both on the roots and leaves, and is proving a difficult pest to control. It is capable of killing the vines outright, and when present in injurious numbers it usually seriously weakens or stunts the vines. New York grape-growers should not fail to familiarize themselves with the pictures and descriptions of this new pest and its work.

It is believed that the information contained in the following pages may help to avert the injury that is threatened, and the report is submitted for publication under chapter 430 of the Laws of 1899.

I. P. ROBERTS, *Director.*

3.— View in a portion of the infested vineyard near Ripley, N. Y. The vines are 7 or 8 years old and should normally cover the trellis with a mass of foliage.

THE GRAPE ROOT-WORM OR GRAPE-VINE FIDIA.

Fidia viticida Walsh.

Order COLEOPTERA; family CHRYSOMELIDÆ.

An insect pest new to New York grape-growers has recently appeared in injurious numbers in some of the vineyards in the great Chautauqua grape region. Early in September we were informed that the vines on several acres of a large vineyard near Ripley, N. Y., were unhealthy, dwarfed, and some had died. A small portion of the affected area is shown in figure 3, as we saw it a few days later. The vines had been set seven or eight years, and should have covered the wires with a continuous mass of green foliage, as did other healthy vines in neighboring vineyards. The vines looked stunted and dwarfed, and what little fruit they bore was very small; see figure 4 for a comparison of the fruit with that from a healthy vine. The vineyard had apparently had good care and the soil was fertile; about 10 or 12 acres were affected. In another vineyard a few rods distant we found vines dying over a small circular area on one side. The vines had made a good growth this season and produced a fairly good crop of fruit, but by September 15th the leaves were falling, some of the fruit was shriveling on the branches, and a few vines were dying. This vineyard was in fine condition and it was a sad sight to see it thus invaded by an enemy.

An examination of the leaves of the affected vines gave us a clue to the depredator. Irregular, narrow, chain-like holes had been eaten in the leaves (see frontispiece and figure 5). It was evidently the work of the beetle of the grape root-worm, and an examination of and around the roots of the affected vines soon revealed plenty of the small white grubs at work on the roots. It was so late in the season that we did not succeed in finding any of the beetles. Mr. Fred Johnson rendered us valuable assistance in our investiga-

tions of the outbreak of this pest in New York; he readily found the grubs on the roots and some eggshells on the bark, but a most careful search failed to reveal any of the beetles as late as September 5th. We feel quite sure that the culprit which is responsible for all the injury to the vines is the insect known as the grape root-worm (*Fidia viticida*).

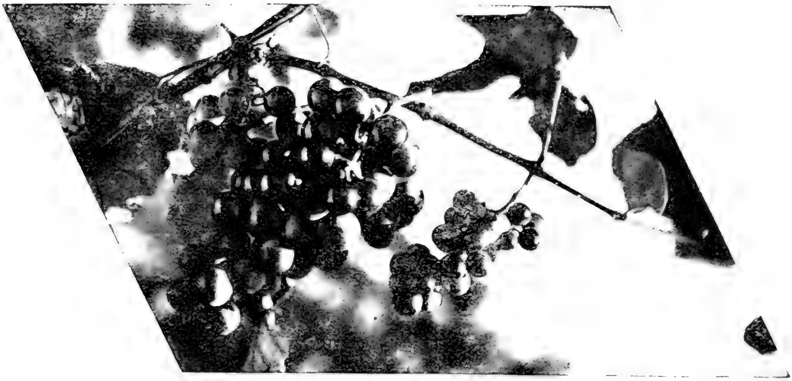
This insect is capable of doing much damage in a vineyard, as is shown in figure 3, and as Ohio grape-growers can testify after several years of sad and costly experience with it. Apparently the insect has never before been recorded as injurious in New York, although the beetle is said to occur on Staten Island and throughout New Jersey, and we have seen a little of its characteristic work on grape leaves at Ithaca, and one or two other places in New York. Thus, all New York grape-growers should acquaint themselves with the insect and its work, and be on the lookout for it in their vineyards.

HISTORY, DISTRIBUTION AND DESTRUCTIVENESS.

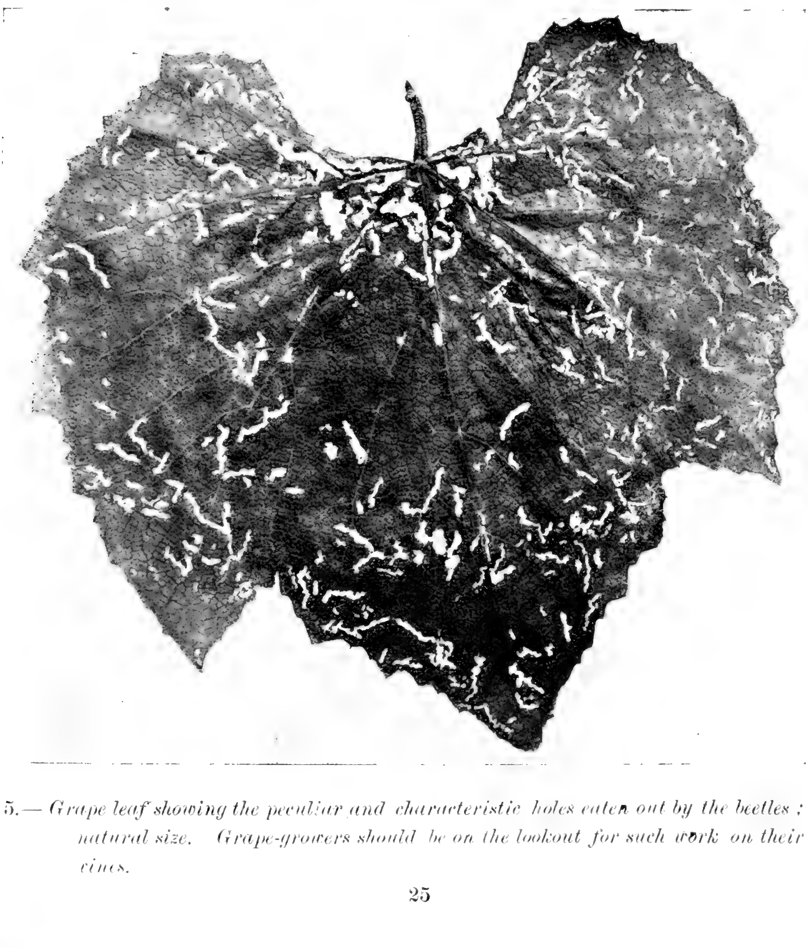
Our recorded knowledge of this grape root-worm begins in 1866 when the beetles were found working on grape leaves in great numbers in Kentucky, and they had been found on native grape-vines in Illinois. The next year the insect received its name of *Fidia viticida*, the grave-vine Fidia, and in 1869 it was considered one of the worst foes to the grape-vine in Missouri. In 1873 and in 1885 the insect was again described as *Fidia murina* and *Fidia lurida*, and in 1888 it was recorded from the vicinity of Iowa City, Iowa. In 1892, it was found injuring the foliage of grapes in Arkansas, and it continued to be injurious there for several years.* The recorded distribution of the insect is through the Middle States to Dakota and southward to Florida and Texas.

Nothing was known of the life-history of the insect or of its early stages and its habits until 1893, when Mr. F. M. Webster, entomologist of the Ohio Experiment Station, began his studies of specimens of the grub sent him from the vicinity of Cleveland, Ohio, "where they were said to occur in great numbers about the roots of grapes, causing very serious injury by eating the outer bark." The follow-

* Arkansas Exp. Sta., Bull. No. 43, p. 14.



4.— *Comparison between fruit on injured vine (smaller cluster) and that taken from a healthy vine nearby (large cluster); reduced from photo taken in the field.*

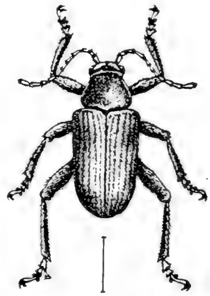


5.— *Grape leaf showing the peculiar and characteristic holes eaten out by the beetles; natural size. Grape-growers should be on the lookout for such work on their vines.*

ing season some of these grubs developed into the beetles known as the grape-vine Fidia, thus establishing the identity of the grubs, and in October, 1895, Mr. Webster published an admirable bulletin (Bull. No. 62, Ohio Exp. Sta.) on the insect. Having had but little opportunity to study the pest in New York, and as Mr. Webster's work has been so thoroughly well done, our statements in this bulletin are largely abstracts of his bulletin, and of his other more recent notes on the insect.

The pest has done much damage during the past six years in vineyards along Lake Erie east of Cleveland, Ohio, and in 1899 a serious outbreak was reported at Bloomington, Ill. It seems to have spread slowly in Ohio, and probably the outbreak in New York near Ripley, in Chautauqua County, has resulted from the eastward spread of the insect. It is evidently spreading slowly near Ripley where 10 or 12 acres of one vineyard have been already practically ruined.

It is to be hoped that its ravages may be limited in our State, for it is the most serious and dangerous insect enemy which has yet made its appearance in our vineyards; it feeds both on the roots and leaves, and it is proving to be a difficult pest to control. It is capable of killing the vines outright, and when present in injurious numbers it usually seriously weakens or stunts the vines.

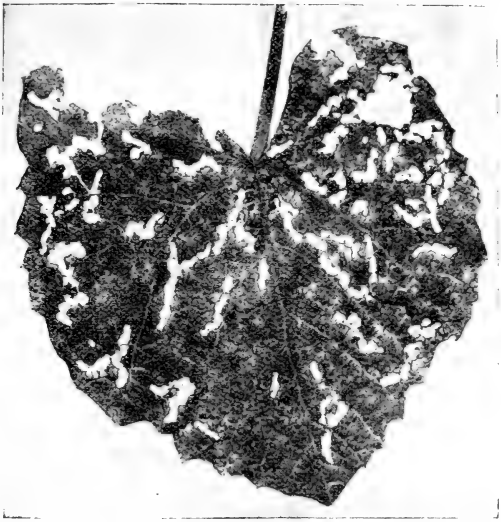


6.— *The adult insect or beetle which eats the chain-like holes in the leaves, enlarged. The line below represents the natural length of the beetle. (From Webster.)*

ITS APPEARANCE AND HOW TO FIND IT.

Grape-growers can readily find the insect in its two active and destructive stages — the beetle and the grub — if they are present in injurious numbers.

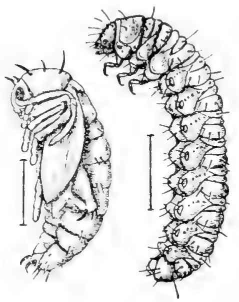
The adult insect is a small beetle about a quarter of an inch in length and of a brown color, rather robust and densely covered with short grayish-white hairs, giving it a hoary appearance. See figure 6. In June and July these beetles may be found eating the peculiar holes in the leaves shown in figure 5. When disturbed they quickly fall to the ground with



8.— Work of the beetles on a small grape-leaf; natural size.

10.— *Portions of three grape-roots nearly denuded of their bark and fibrous rootlets by the grubs (below), and part of a similar root taken from a thrifty vine showing its normal bark and rootlets. Reduced in size.*

their legs folded up against the body and feign death or "play possum." They belong to the family of Leaf-beetles or Chrysomelids, and are thus closely allied to the asparagus beetle, the Colorado potato beetle, the grapevine flea-beetle and many other insect pests.



7.—*The grub or larva (at the right) and the pupa, enlarged. Most of the injury is done by the grubs which work on the roots. The lines at the left of the figures represent the natural length of the objects. (From Marlatt).*

The larva of this pest is a small white grub, not quite half an inch long when full grown, and it has a yellowish head and cervical shield, with its mouth parts darker. Its general appearance and form is well shown in figure 7. These grubs live in the soil where they feed upon the roots of the vines. They may be found by carefully examining the soil around the roots of the infested vine at almost any time of the year except in June and July.

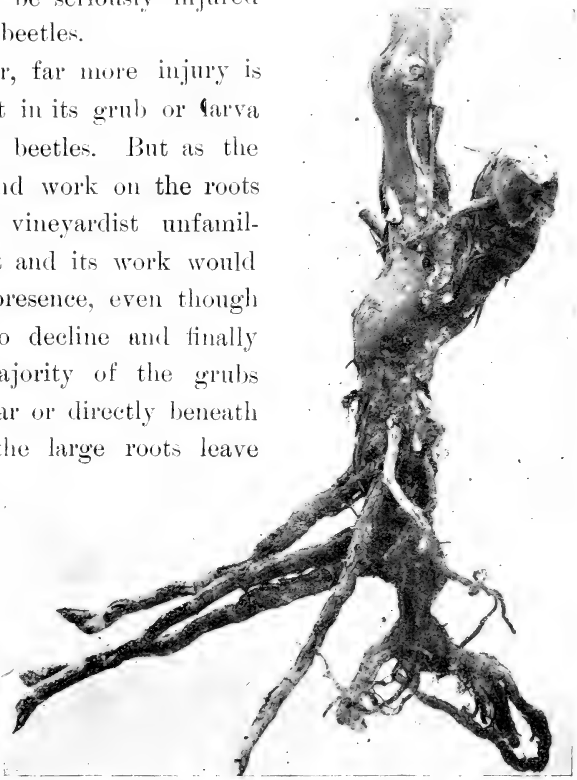
The grub transforms to a white and tender pupa, figure 7, in June in earthen cells formed near the grape roots by the grubs. The pupal stage lasts about a fortnight, when the transformation to the beetle takes place.

THE INDICATIONS OF ITS PRESENCE, AND HOW IT WORKS.

Fortunately this pest works in such a way as to enable one to easily recognize its presence in a vineyard, and often before serious damage has been done. The work of the beetles is especially conspicuous and characteristic. They feed entirely upon the upper surface of the leaves, beginning on the lower leaves in the latter part of June and later in the season working higher up on the youngest and most tender foliage; sometimes they also attack the fruit. They eat "by gathering a quantity of the substance of the leaf in their mandibles or large jaws and jerking the head upwards, after which the body is moved a step forward and another mouthful of food is secured as before. After securing a few mouthfuls in this way they move to another place and begin again, thus eating out numerous chain-like areas of irregular length," as is well shown in figures 5 and 8. Leaves eaten in this peculiar manner could

hardly escape the eye of any vineyardist on the lookout for this pest. On varieties of grape having a velvety under-surface to the leaves the beetles eat only to the lower skin, on others entirely through the leaf. Some leaves may be riddled by them, as shown in the picture on the title-page. Look for the work of the beetles from the latter part of June until the leaves drop in autumn. Young vines may be seriously injured in this way by the beetles.

Usually, however, far more injury is done by the insect in its grub or larva stage than by the beetles. But as the grubs are small and work on the roots underground, the vineyardist unfamiliar with the insect and its work would not suspect their presence, even though his vines began to decline and finally died. A large majority of the grubs are to be found near or directly beneath the point where the large roots leave the trunk, and "it would appear that the very young grub, after it has fed for a short time on the small fibrous roots, turns its attention to the larger and tougher portions, eating off the bark, and following the smaller roots outward. Where the grubs are numerous and as many as 68 have been taken from about a single vine, the injured roots simply rest on a bed of the castings of the grubs."



9.—*Portions of large roots and trunk of grape-vine killed by the grub. Note that most of the fibrous roots have been eaten off by the grub.*

Figure 9 shows a portion of the larger roots and trunk of one of

the grape-vines found dying from the attacks of the grubs near Ripley, N. Y. Note that most of the fibrous rootlets have been eaten off. The differences between injured and uninjured roots are well shown in figure 10; nearly all the bark and the fibrous roots have been eaten off the three portions of roots shown on the right. When the grubs have thus denuded the larger roots of their bark and fibrous rootlets, the vine usually succumbs, but may lead a lingering existence and partially recover if the attack is not continued. This was evidently the case in the vineyard shown in figure 3. Some of the vines had been killed by the pest while many others had begun to recover, and new fibrous roots were developing, but the vines will doubtless never fully recover, and one had better dig out such vines, and, after a year or two of other crops, set new vines.

PLANTS ATTACKED.

Besides the cultivated varieties of grape, the beetles have been found feeding only on the wild grape-vine, on the leaves of the red-bud or Judas-tree, and in New Jersey on *Ampelopsis*.

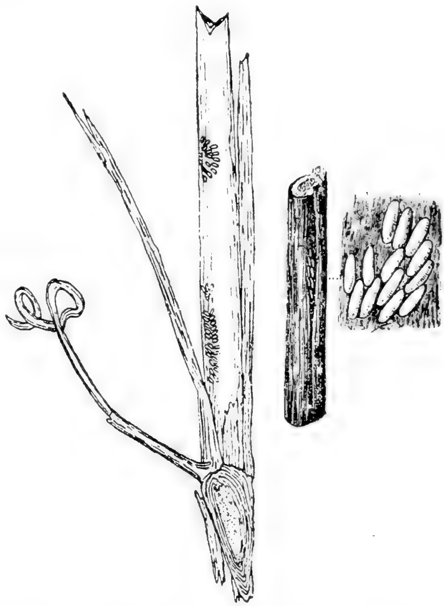
ITS LIFE-STORY.

By his investigations in 1894, Mr. Webster of the Ohio Experiment Station was the first to unravel the mystery which had previously enveloped the early stages of this pest.

The egg-stage.— He discovered the yellowish eggs laid in large batches, usually placed under the slightly loosened bark of the previous year's or even an older growth, often several feet above the roots. Several dozen eggs are frequently found in a single cluster, the ends pointing obliquely toward a common center. Over 700 eggs have been found on a single vine in Ohio, but the number each female beetle may deposit is not known. Very rarely the eggs may be pushed into cracks in the soil about the base of the vine, and as they are often loosely attached to the bark they not infrequently fall to the ground from the swaying of the vine by the wind. Egg-laying begins in the latter part of June and doubtless continues during July. The eggs hatch in about eight days.

Habits of the grubs.— Mr. Webster states that he "lay on the

ground and with a hand-glass or magnifier watched the minute grubs leave the egg and, after crawling about for a short time, fall clumsily to the ground, not a single individual being observed to make its way down the vine. On reaching the ground there was no attempt made to burrow downward, and the roots appeared to be reached by the way of the cracks and crevices in the earth, or directly down about the base of the vine, where, as a matter of fact, the larger number would naturally fall, though it is doubtful if more than one grub out of a hundred hatching from the eggs would succeed in reaching the roots at all. Still, as the little grubs will live for a week or more without food, and can run about on the ground quite actively, it is not strange that many of them should find their way to one of the many fresh succulent fibrous roots that are found near the surface of the ground, though I have seen them die in dropping on the hot sand. In the spring grubs have been found fully three feet from the trunk and nearly a foot below the surface. The grub appears to develop very rapidly, many having reached their full growth by the middle of August." On September 18th, we found some of the grubs still at work on the roots in New York.



11.—*Eggs, enlarged (at the right), and natural size as laid in cracks of the bark. (From Webster and Marlatt.)*

When the grubs get full grown in early autumn, they work their way a little to one side of the root and form little earthen cells, within which they remain curled up without food during the winter and until the following June, thus spending about nine months in this manner.

The work of the grubs in the roots is illustrated in figures 9 and 10.

Pupation.— In June these over-wintered grubs undergo the transformation to the white and tender pupa shown in figure 7. "In northern Ohio the grubs pupate largely at least, in June, though I have found pupæ in limited numbers on the 8th of August. A very few pupæ may be observed as early as the first week in June, and by the 23d fully ninety per cent of the grubs have passed into this stage," says Webster; doubtless about the same conditions will be found in western New York. The pupal stage lasts about a fortnight, when the final transformation to the adult insect or beetle occurs. No injury is done by the insect in the pupal stage as the pupæ do not eat.

Period of activity of the beetles.— The beetles begin to appear during the last week in June and soon begin their injurious work on the leaves (see figures 5 and 8). They pair soon after emerging. Most of the beetles die by August, but some that emerged late may be found on the vines as late as September 1st.

There is thus but one brood of the insect in a year, but it is injurious in both its grub and beetle stages, thus making it a formidable pest. The grubs do most of their feeding in August, and the beetles in July, so that the insect will do most of its damage during these two months in New York.

NATURAL ENEMIES.

No natural enemies have been observed preying upon the beetles, pupæ, or grubs or this grape root-worm, although it is probable that insectivorous birds eat some of the beetles. But several animals were observed to include the eggs in their menu in Ohio. "The little brown ant, *Lasius brunneus* var. *alienus*, was observed several times in the act of feeding upon them though they could only reach such as were much exposed. A small mite possibly *Tyroglyphus phylloxeræ*, was frequently observed to approach a cluster of eggs and extract the contents of several in succession, while still another smaller mite, resembling *Hoplophora arctata*, was several times found similarly engaged." Mr. Webster also bred two new species of minute Hymenopterous parasites from clusters of the

eggs; one of these was *Fidiobia flavis* Ashmead, a Platygaster, and the other a Trichogrammid named *Brachysticha fidiæ* by Ashmead.

Webster stated in 1866 that the ravages of the pest seemed to be on the decline in Ohio, and he then thought it due to the increase in numbers of the enemies of the eggs. The little Trichogrammid parasite had increased enormously in the preceding two years and he also found another mite (*Heteropus ventricosus*) eating the eggs. In 1899, however, Mr. Webster found the pest unusually abundant in the infested localities in Ohio, and he stated that "the injury from last year's grubs was very serious despite the increase in influence that we had hoped for from the two egg parasites."

We hope that some or all of these enemies of this pest are at work in New York, but apparently there is little hope that they will keep it in check.

REMEDIAL MEASURES.

The fact that this grape root-worm may injure the vine as a beetle attacking the leaves, and also as a grub feeding on the roots, makes it a serious menace to grape-growing. And it becomes a still more serious matter when we learn that no thoroughly satisfactory method of controlling the insect has been found in Ohio after several years of experience with the best remedial measures which could be devised.

There are good grounds for believing that if the soil is kept in a loose and well pulverized condition and banked up slightly toward the row, thus covering the roots more deeply with light soil that will not crack, many of the newly hatched grubs will be unable to reach the roots that would otherwise do so. This method will not constitute a full protection from attack, but it will help very materially in the warfare. *Keep the soil about the base of the vines finely pulverized by frequent cultivation and cover the roots deeper during the period of egg-hatching or during the month of July.* "Whatever management will tend to cause the roots to grow deep in the soil, and prevent the growth of roots near the surface, will also tend to ward off attack on the same principle as the mounding," says Webster.

The precautionary habit of the beetles of dropping quickly to the ground and "playing possum" when the vine is unnaturally disturbed as by sudden jarring, offers a vulnerable point of attack.

This was taken advantage of in 1867 by one grape-grower in Missouri who called to his aid a large brood of chickens which he had raised. It is said that he "had them so well trained that all he had to do was to start them in the vineyard with a boy in front to shake the vines, and he himself behind the chicks. They picked up every beetle which fell to the ground, and in this manner he kept his vines so clean that he could scarcely find a single beetle in 1868." While we were investigating the outbreak of this pest near Ripley, N. Y., a man who owned a fine vineyard very near the two which had been seriously injured by the insect, said that his flock of chickens had the run of his vineyard and he was sure he had seen them eating many of the beetles. *Wherever it is practicable, give a flock of chickens a chance to help in the warfare against the pest.*

An effort was made in Ohio to kill the beetles, which were "playing possum" on the ground, by spraying them with kerosene emulsion of various strengths and with pyrethrum in solution (one ounce to two gallons of water) and some that were thoroughly drenched were killed, but many recovered, and the method was abandoned.

It may be practicable in some cases to jar the beetles off onto sheets or an inverted umbrella-shaped apparatus, as many now catch the plum curculio.

As the beetles feed openly on the upper surface of the leaves, one can easily feed them poison with a spray pump. Arkansas vineyardists report "only fair success in efforts to poison the beetles." The first experiments in Ohio with Paris green and London purple, using 1 pound with 5 or 6 pounds of lime in 100 gallons of water, were very encouraging, as many of the beetles were killed. But in 1896 Mr. Webster reported that "the beetles do not yield at all readily to poisons;" in 1899, he reports that "at present there are some grounds for hoping that arsenate of lead (Bowker's 'arsenic lead') may prove effective in killing off the beetles before they have oviposited." Evidently it requires a strong dose of poison to kill the beetles quickly enough. The application should be made at least as early as the 25th of June, and not later than July 15th. The arsenate of lead, although more expensive, is to be recommended in preference to other poisons, as it will stick on the foliage

much longer and there is not the danger of burning the leaves with a strong mixture that there would be from using Paris green and similar poisons. Use 2 or 3 pounds of the arsenate of lead in 150 gallons of water. *Spray infested vines between the 25th of June and July 15th with a strong poison to kill as many of the beetles as possible before they lay their eggs.*

Efforts were made in Ohio to kill the beetles on the vines with kerosene emulsion of various strengths but it was of no avail and it spotted the fruit very badly. Whale oil soap was also tested, but it neither killed the beetles nor acted as a repellant to drive them away. They also had poor success in driving away the beetles with an application of a strong Bordeaux mixture.

The eggs of the insect can be killed with kerosene emulsion but only a comparatively few eggs on a vine can be reached with a spray, they are so snugly tucked under the bark, and the emulsion also spotted the fruit. *Thus, no practicable method of reaching the pest in the egg stage has been devised.*

As the newly-hatched grubs drop to the ground and do not crawl down the vine, there is no chance to capture them with a band of tar or some other adhesive substance placed around the vine. It was thought that air-slacked lime scattered along under the vines might kill the young grubs that fell upon it, but it proved ineffectual.

When the grubs once get into the soil, like all insects which work underground, it is usually a difficult and expensive matter to kill them. Many efforts have been made in Ohio to reach these grubs feeding on the roots. It is possible that if a gallon or two of kerosene emulsion be poured into a basin-like cavity around the base of the vine and then thoroughly washed in with water, that many young grubs might be killed during the latter part of July, but this method would not be found practicable in many places and has not yet been proven effective.

Tobacco dust was thoroughly tested in Ohio in amounts ranging from one-half pound to four pounds placed about the base of each vine, but apparently no grubs were killed. Similar extensive experiments with kainit, using from one-half pound to eight pounds to each vine, showed that while this fertilizer will penetrate the soil to a depth sufficient for all practical purposes, it can hardly be

made strong enough to be effectual against this pest; in one case, where four pounds had been applied to a vine, the grubs were found at work uninjured in soil among which the kainit was clearly perceivable.

The bad-smelling liquid, carbon bisulphide, which volatilizes quickly when exposed to the air, is one of the most effective insecticides now in use against underground insects. It has been thoroughly tested by Ohio grape-growers in their efforts to check the grape-root worm. In summing up the results of his experiments in 1894, Mr. Webster states that "carbon bisulphide cannot be used to advantage earlier than November, on account of the prolonged season of oviposition, which prevents the later appearing grubs from working downward to a sufficient depth to be reached by the fumes. It cannot be used to advantage in soil that is very dry or saturated with water, but must be used in soil that is damp. The most satisfactory results will probably follow its use in spring, in a damp soil, and applied in such a manner as to fumigate the roots without the fluid coming in contact with them, and when from four to six ounces per vine are used. It is not possible to kill every worm about each vine, and it is doubtful if it can be used profitably when the price of fruit is low." In 1896, he reports that "so far have found bisulphide of carbon too expensive." This liquid is the most effectual of anything yet used against the grubs feeding on roots. But it is not easy to apply properly, requiring some such instrument as the McGowen Injector, care must be taken not to let the liquid touch the main roots, and the soil must not be too dry or too wet. The liquid to treat each vine would cost about three cents, and it may be obtained in quantities of Edward R. Taylor, Penn Yan, N. Y., for about ten cents per pound.

In brief, we would advise vineyardists who have this pest to fight to keep the soil thoroughly pulverized and mounded around the base of the vines in July; manage to have the roots grow deep in the soil and not near the surface; use freely some fertilizer that will stimulate growth and thus overcome the effect of any slight attack of the grubs on the roots; wage a vigorous warfare against the beetles with chickens or with a poison spray, beginning as soon as they emerge in the latter part of June so as to kill as many as

possible before they lay their eggs; in many cases, we believe that thorough work against the beetles, supplemented by the cultural methods suggested above, will so effectually check this pest that it will not be necessary to resort to the expensive, yet very effective, treatment of the soil with carbon bisulphide.

New York grape-growers should not fail to familiarize themselves with the pictures and descriptions of this new pest and its work, as it is the most serious insect enemy that has yet threatened the industry in this State.

MARK VERNON SLINGERLAND.

EDITION LIMITED.

Bulletin 185. **November, 1900.**

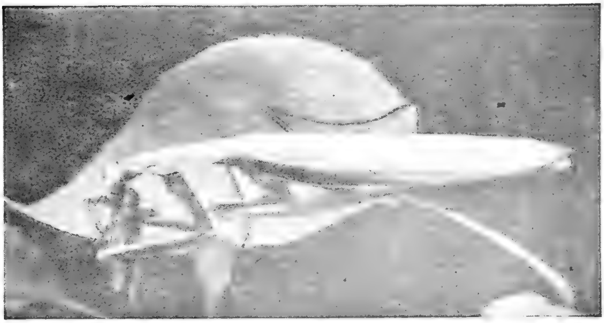
Cornell University Agricultural Experiment Station,

ITHACA, N. Y.

ENTOMOLOGICAL DIVISION.

THE COMMON EUROPEAN PRAYING MANTIS

A New Beneficial Insect IN AMERICA.



By M. V. SLINGERLAND.

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A NEW BENEFICIAL INSECT IN AMERICA.

THE COMMON EUROPEAN PRAYING MANTIS.

Mantis religiosa Linnaeus.

Order Orthoptera ; family Mantidae.

We too often forget that many kinds of insects are beneficial to man, either by helping him destroy his insect pests or, like the busy bee, visiting his blossoms and often leaving an insurance policy in the shape of tiny grains of pollen, which insures a crop of fruit that otherwise might be extremely uncertain. It is therefore with much pleasure that we are able to announce the advent of a new beneficial insect into New York State. It this case the insect was doubtless accidentally introduced or imported from Europe, and curiously enough, although it has inhabited Europe, Asia and Africa doubtless for centuries, it has apparently never before obtained a foot-hold on the American continent. In these days of rapid commerce between all nations of the globe, one can scarcely wonder that many insects are carried in various ways from their native home, and some of them often succeed in establishing themselves in far distant lands. Many of our worst insect pests, like the cabbage butterfly, the pear psylla, and the Hessian fly, were foreigners which unfortunately are now too thoroughly naturalized in our country.

In the case of insects injurious to fruits, the American nurserymen are often justly accused of importing these pests, and especially of spreading them broadcast over the country. That our nurserymen have also brought beneficial insects into the country must not be forgotten, however; although the beneficial effects of these insect friends are very meagre compared with the losses inflicted by the introduced foreign insect pests. We are undoubtedly indebted to the nurserymen for the importation of the wonderfully interest

ing beneficial insect that has now established itself in New York, and to which the following account of its characteristics and interesting habits is addressed.

How the Insect Looks.

The principal characteristics of this new insect friend are well shown in the reproductions from photographs taken from life, natural size, in figure 12. It is a large, slender, conspicuous insect, unlike any other insects in this country north of southern New Jersey and Pennsylvania. It presents such a striking and rather ungainly appearance that one could scarcely fail to recognize it. But it might easily escape one's notice, for it often remains practically motionless for hours, and its peculiar attitude and shape, with the fact that some of the specimens are light brown in color while others are apple green, causes them to closely resemble the branch among the leaves of which they may be patiently waiting for their prey. Some other species of these extraordinary insects have wings which resemble the leaves of plants in form and coloring. The insect varies considerably in size, the females usually being the larger. The specimens shown at *c* in figure 12 are nymphs or immature forms; note that the wings are mere pads on the sides of the body. The most striking characters of the insect are the great length of the first segment of the thorax, it being the largest segment of the body, and the enlarged front legs, which are peculiarly fitted for grasping, and being armed with spines, to hold their prey when captured.

Its Name.

These extraordinary insects were known to the ancient Greeks as *Mantes*, a word meaning a prophet. Mouffet writing over three hundred years ago says: "They are called *Mantes*, that is *foretellers*, either because by their coming (for they first of all appear) they do show the spring to be at hand, so Anacreon the poet sang; or else they foretell death and famine, as Caelius the Scoliast of Theocritus has observed; or lastly, because it always holds up its fore feet like hands praying as it were, after the manner of their Diviners, who in that gesture did pour out their supplications to their Gods." Another writer states that the name of *Mantes* was

evidently bestowed upon these insects from their attenuated form; in one of the Idylls of Theocritus the word was employed to designate a thin, young girl, with slender elongated arms.

As Comstock says: "Certainly they are pious-looking fellows, with their front legs clasped together in front of their meek, alert faces, and it is no wonder that they are called Praying Mantes in most countries. But the only prayer that could ever enter the mind of a Mantis would be that some unwary insect might come near enough for him to grab it with his hypocritical claws, and so get a meal. Devil-horses, rear-horses and camel-crickets are other names applied to these insects, because of the long, slender prothorax which makes them look like tiny giraffes. (Some of their characteristic attitudes are well shown in figure 12.) They are also called mule-killers, from the absurd superstition that the dark-colored saliva they eject from their mouths is fatal to the mule. But they are absolutely harmless to man and beast."

In South Africa they are often called the Hottentot's God, and in other countries many call them soothsayers. The prayerful or begging attitude assumed by these insects suggested many of the specific scientific names which have been applied to them, as *Mantis religiosa*, *pagana*, *sancta*, *supplicaria*, *oratoria*, *mendica*, *pauperata* and *superstitiosa*.

Its Discovery in New York.

When this Praying Mantis arrived in this country is not known, but the honor of its discovery here belongs to Mr. H. F. Atwood, a noted microscopist at Rochester, N. Y.

In a letter dated October 20, 1899, he wrote us that "this past season I have taken a number of specimens of *Mantis*. My home is on the northern outskirts of Rochester and I have found many of them about my house and they were also taken about Charlotte and Summerville. I did not hear of any further south. Early in the spring I found a cluster of the eggs on a twig that had been blown from a tree. I identified it, but not to my satisfaction, for until I saw the perfect insect I had no idea of their being found here. The specimens I observed were good feeders, and in my opinion they should be encouraged as their diet was entirely insects."

As none of our American Mantids breed normally north of southern New Jersey and Pennsylvania, we were naturally much interested in Mr. Atwood's discovery, and supposing, of course, that it was a case where our common southern Mantid (*Stagmomantis carolina*) had finally succeeded in establishing itself in New York, we published a brief note to this effect in Entomological News for December, 1899. We have raised this southern species and another from New Mexico here at the insectary from eggs received from these localities, and Glover states that the former "has been successfully raised as far north as the Hudson river, by bringing the egg-cases from the South." Several egg-cases were found fastened to trees the next autumn, but after that they entirely disappeared. It is said that the eggs probably could not endure our northern winters. As none of the Mantids seen near Rochester in 1899 were preserved, we awaited the season of 1900 with much interest to see if the insect had survived the winter and to definitely determine just what species of Mantid it was. And we were not disappointed.

On March 13th, 1900, Mr. Atwood sent us two of the egg-cases which a little girl had found up under the water-table of a dwelling house. However, all the eggs they contained were dead and shriveled, indicating that the insect had not been able to survive the winter. But a month later came several more egg-cases, and most of them were evidently alive; most of these were found attached to grass stems near the ground. We placed these in a breeding cage, and on May 24th, 1900, we were delighted to find that young Mantids were hatching from the egg-masses, thus proving that the insect had established itself and was breeding freely near Rochester. July 7th Mr. Atwood sent us a young Mantid about an inch long that he had captured near his home, and by July 21st several of ours in the cages had attained over half their growth, but a majority had succumbed to the cannibalistic habits of their brothers and sisters and to other vicissitudes of an insect's life. By the middle of August our few remaining specimens had become full grown, and Mr. Atwood sent us a female which, by August 29th, had laid an egg-case in our cage. He wrote that the territory of the insect seems to be enlarging, as it had been found across the river over Irondequoit, near Rochester.

It now remained to learn what species of Mantid had thus established itself in New York, 200 or 300 miles further north than any such insect lived in this country.

ITS IDENTIFICATION.

Specimens of the adults were sent to an expert, Mr. Scudder, for determination, and the following reply came on September 20th, 1900. "The specimen you sent was very perplexing. I never for a moment thought it was anything but an American species, and all the tables for generic determination in the Mantinæ separated at one point the Old World from the New World forms *en masse*. Everything in the New World tables brought it down haltingly to *Stagmomantis*, and yet it was no *Stagmomantis*, so I turned just now to the Old World series, and there at once I brought it down to *Mantis*, and, on comparing specimens, to *Mantis religiosa*, the common European form."

ITS DISTRIBUTION.

It is common in southern Europe, especially in France, and its northern limit is from 47 to 49 degrees north latitude or near Havre, Freiburg and Vienna; it also occurs in Asia as far as Hindustan and Java and in Africa as far south as Zanzibar. It thus has a very wide distribution in the Old World, but has never before been reported in the New World.

Here it is apparently yet confined to a small area near Rochester, including the towns of Charlotte, Summerville and Irondequoit, where it has become quite common.

And Miss H. F. Samain, Principal of Public School No. 11, in Rochester, writes concerning some specimens she sent us recently: "I found them crawling by the side of an unused road just south of the Driving Park in the northwest part of our city. Others were found in the field which the road bordered, crawling up the grass stalks. One was found sunning itself in the middle of the day on the sidewalk near No. 34 school. The children who live in that vicinity told me that they had seen them come out of the grass onto the sidewalks and iron-work of the school-house. A great many were taken from that field a year ago, and there does not seem to be

as many there this year. I know of one being found recently on the east side of the river, from Seneca Park, I think."

This beneficial insect is thus apparently well established in the vicinity of Rochester where it is slowly spreading. We shall endeavor to establish it at Ithaca. It will be a very welcome addition to the insect fauna of New York.

ITS HABITS AND LIFE-HISTORY.

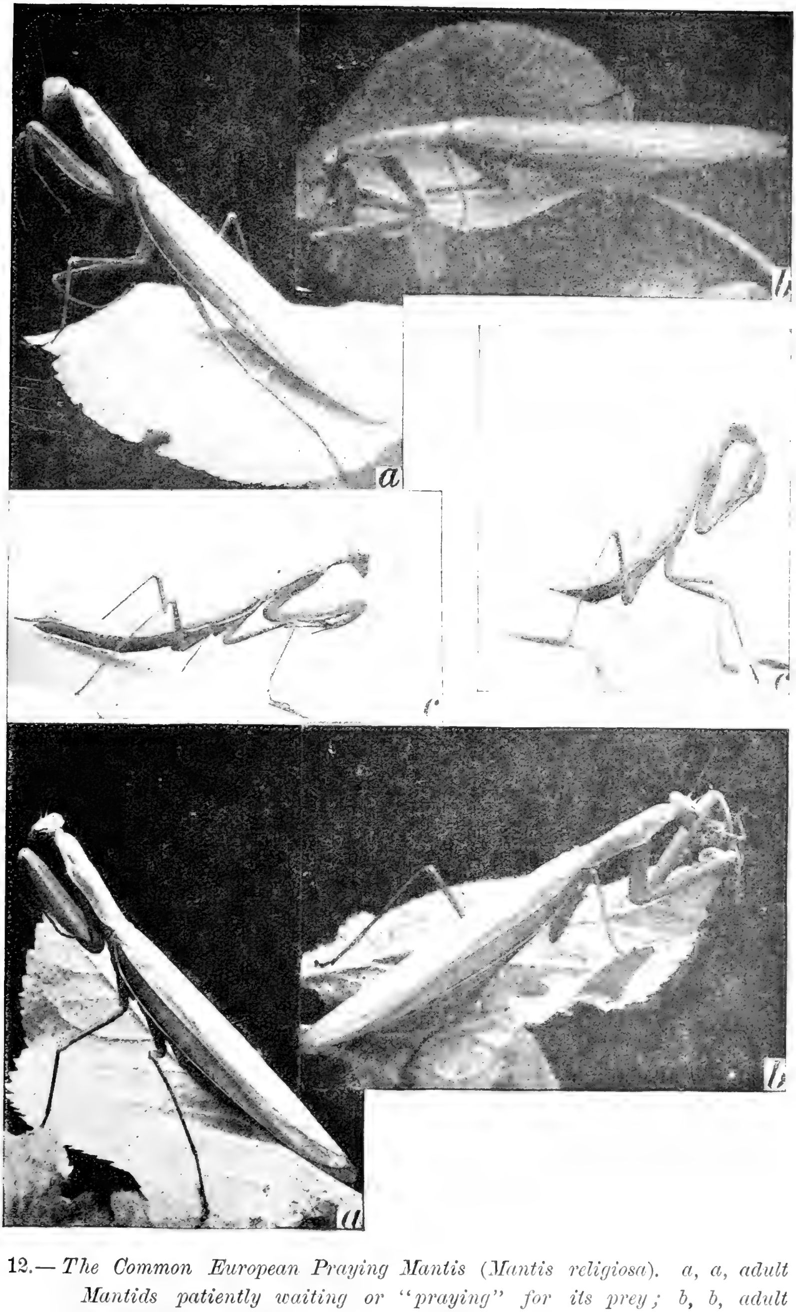
The Praying Mantes, unlike most other members of the great order Orthoptera (the crickets, grasshoppers, walking-sticks and cockroaches), which are mostly vegetable feeders, are carnivorous, usually eating only living insects and other small animals. Mr. Atwood writes us that "their diet is not confined absolutely to insects, as a little girl in our neighborhood holds them by the thorax and gives them crumbs of bread which they take readily and eat."

As Mouffet quaintly said more than three hundred years ago: "They resemble the Diviners in the elevation of their hands, so also in likeness of motion; for they do not sport themselves as others do, nor leap, nor play, but walking softly, they retain their modesty, and shewes forth a kind of mature gravity." They move about rather slowly and ungainly, and often wait for hours in the attitude shown at *a* in figure 12 for some unwary creature to come within reach. When prey is sighted, they often creep up silently, much like a cat, and when close enough make a quick dash, seizing their prey with their spined forelegs, as shown at *b* in figure 12. The power they can exert in holding their prey is surprising as we have learned when they grasped our finger when handling them.

Both sexes possess well developed wings, and the males are said to fly some after sunset, but the female does not fly, but sometimes uses her wings to ease herself from a higher to a lower elevation, also when in battle, or when pouncing upon her prey, at which time she hoists them very much as does a swan when irritated.

There are many interesting and sometimes startling accounts of the voracity and bloodthirstiness of these creatures.

Our common southern species (*S. carolina*) has been known to attack butterflies, grasshoppers and caterpillars of various kinds,



12.— *The Common European Praying Mantis (Mantis religiosa). a, a, adult Mantids patiently waiting or "praying" for its prey; b, b, adult Mantids busily engaged eating live grasshoppers which they have captured with their strong spined front legs; c, c, Mantid nymphs or young Mantids ready to grab any unwary creature. All natural size from photos taken from life.*

and in one case a female devoured eleven Colorado potato beetles during one night. Another record * states that a female ate in a few days dozens of flies, several large grasshoppers, some young frogs, and finally a striped lizard three times as long as itself! In Buenos Ayres a species of Mantis is said to seize and eat small birds.

We quote from Mr. Atwood's letters the following interesting observations on the feeding habits of *Mantis religiosa* at Rochester: "They seem to be sociable, as I found one in my dining room. A friend was entertained by one of them that was inside of his window very busy trying to catch a spider that was on the other side of the glass. The window was opened and the Mantis went out and caught the spider. One Sunday a green Mantis ate three grasshoppers, each seven-eighths of an inch long, a daddy-long-legs, and then tackled another Mantis, and I was obliged to interfere between them. In a corner of my house I found the remains of a Mantis in the web of a large spider. I did not see the tragedy, but I imagine the spider caught the Mantis at a disadvantage. In eating a grasshopper, I notice that the usual rule is to commence with the head and nothing is left except the terminals of the two hind legs, the wings, and the contents of the alimentary canal. I have one black mark against the Mantis, as I find that it will assassinate and devour a honey bee as readily as a grasshopper. I fed four grasshoppers to a Mantid yesterday and all were devoured. I find that they are not disposed to indulge in luxuries and cast one side a minute parasite (probably *Trombidium locustarum*) on one of the grasshoppers."

After many unsuccessful efforts in trying to get a Mantis to stop eating a grasshopper long enough to have its picture taken, we finally succeeded, when it stopped a moment to lick its jaws, in getting the pictures shown at *b* and *b* in figure 12. It is an interesting yet cruel operation to observe; we have often seen the grasshopper struggle after it had been more than half devoured. It is said that in Melbourne, Australia, Mantids are often placed in windows so that the rooms may be cleared from flies by the indefatigable voracity of the creatures.

---

* Zimmerman in Burmeister's Handbuch der Entomologie, II., 538.

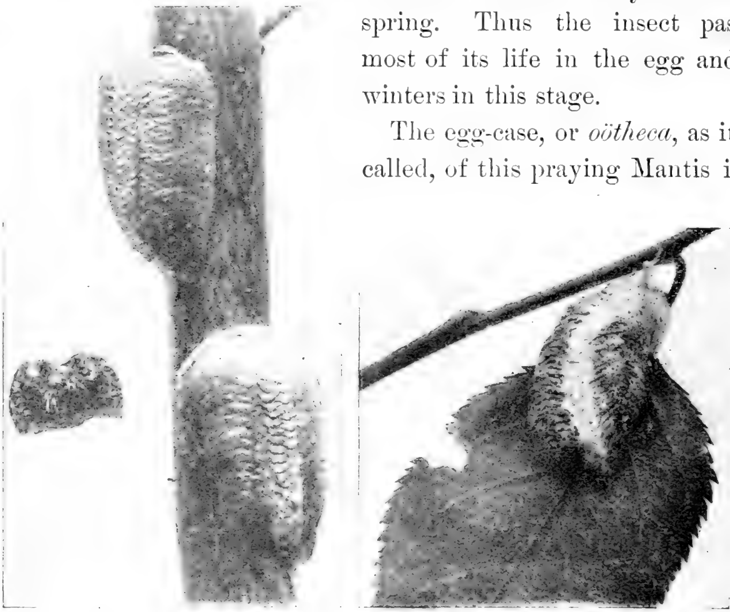
They are also cannibals.— Dr. Riley has graphically portrayed the cannibalistic habit of these bloodthirsty creatures which are forever quarreling and at enmity among themselves, as well as with all other insects. " Many a fierce battle is fought by the males in which neither eye nor limb is spared, and in which the winner ends by making a repast of the body of the vanquished. They are so void of feeling that the male risks his life in courting, and usually succeeds only by slyly and suddenly surprising his mate, who after accepting his embrace, often coolly seizes and devours him. So tenaciously do these insects fight that they will continue without cessation or inconvenience for some minutes after the loss of their heads. We have seen a female, decapitated and with her body partly eaten, slip away from another that was devouring her, and for over an hour afterwards fight as tenaciously and with as much *nonchalance* as though nothing had happened." An instance is recorded in which the female Mantis first cut off the head of her mate, after which coupling took place, which was followed by the female devouring the male. In their mutual conflicts, one writer observes that their maneuvers very much resemble those of hussars fighting with sabres; and the Chinese, aware of their savage, pugnacious propensities, often keep these insects in cages and match them together in combats, as is done with fighting-cocks. Rösel, who published many interesting observations about these creatures nearly 150 years ago, states that they are, however, as cowardly as barbarous, for the instant that he introduced some ants amongst them, the Mantids endeavored to escape in every direction.

Dufour has recorded that *Mantis religiosa* possesses the power of producing a mournful sound by rubbing the extremity of the body against the wings. Mr. Atwood also writes us " that one day when two of his Mantids observed each other they made a whirring noise by rubbing a leg against a wing in order to frighten the other, and each watching the other very closely, and on the alert to give a spring."

The eggs.— In Europe this Praying Mantis lays its eggs in September and they hatch the following June. Our observations

indicate that this statement is also true for New York, although one egg mass was laid in our cage August 29th and we had young Mantids hatch on May 24th last spring. Thus the insect passes most of its life in the egg and it winters in this stage.

The egg-case, or *oötheca*, as it is called, of this praying Mantis is a



13.— *Egg-cases or oötheca of Praying Mantis. Natural size.*

very large, thick, elongate, light-brownish colored mass. Three of these curious egg-cases are shown in figure 13; the two on the left were found on the side of a house and we fastened them to the branch, while the other on the right was laid on the leaf in one of our cages. Two others, perhaps more typical egg-cases, are shown in figure 14 as they were found by Mr. Atwood in the field.

Mr. Atwood observed that in one case copulation between the sexes lasted 24 hours and was then broken up by a heavy rain. He did not get a chance to see the eggs laid and we were equally unfortunate. Rösel saw the operation 150 years ago, with a closely allied, if not identical, species and he states that it took the female two hours to complete the task. Sharp says "the eggs of Mantidae are deposited in a singular manner: the female, placing the extremity of the body against a twig or stone, emits some foam-like matter in which the eggs are contained. This substance dries and forms

the oötheca; whilst attaining a sufficient consistence it is maintained in position by the extremity of the body and the tips of the elytra, and it is shaped and fashioned by these parts. The eggs are not, as might be supposed, distributed at random through the case, but are lodged in symmetrically-arranged chambers, though how these chambers come into existence by the aid of so simple a mode of construction does not appear. The capsule is hard; it quite conceals the eggs, which might very naturally be supposed to be sufficiently protected by their covering: this does not, however, appear to be the case, as it is recorded that they are subject to the attacks of Hymenopterous parasites." This description of the egg-case well applies to the eggs of our *Mantis religiosa*, but as yet, fortunately there are no indications that any of its European enemies were imported with it.

It seems scarcely possible that one female Mantis could lay more than one of these egg-cases, yet Mr. Atwood says in sending us the two egg-cases shown in figure 14: "Recognizing, as I do, the feeling between the specimens, I cannot but think that both these clusters were deposited by the same insect." This is possible, for Trimen records that a South African Mantid constructed four nests of eggs at intervals of about a fortnight. In our cages only one egg-cluster has been laid by a female, and the insect died soon afterward. But Zimmerman states that a specimen of our common southern species (*S. carolina*) which he captured on October 3d, laid one egg-case the next day, and instead of dying as he expected, it ate voraciously, its body enlarged and on the 24th of the same month it occupied several hours in laying another similar egg-case; still the insect remained alive, was fed, its body again enlarged as though it would lay again, but it remained alive until December 27th and died without making a third egg-case. The eggs in the first mass hatched May 20th and those in the second mass three days later.

Mantis religiosa seems to lay its eggs in various situations near Rochester; sometimes on the sides of a house, again on the twigs of trees, but apparently most often on the stems of grasses, as shown in figure 14.

Habits of the young Mantids or nymphs.—Sharp states that

"the young have to escape from the chambers in which they are confined in the egg-cases; they do so in a most curious manner; not by the use of the feet, but by means of spines directed backwards on the cerci and legs, so that when the body is agitated advance is made in only one direction. The eggs last deposited are said to be the first to hatch. On reaching the exterior the young Mantids do not fall to the ground, but remain suspended, after the manner of spiders, to the oötheca by means of two threads attached to the extremities of the cerci; in this strange position they remain for some days* until the first change of skin is effected, after which they commence the activity of their predatory life. When the young of *Mantis religiosa* merges from the egg, it bears little resemblance to the future insect, but looks more like a tiny pupa; the front legs, that will afterwards become so remarkable, are short and not different from the others, and the head is in a curious mummy-like state, with the mouth-parts undeveloped and is unflexed on the breast; there are, says Pagenstecher, nine abdominal segments. The first ecdysis (shedding of the skin) soon takes place and the creature is thereafter recognizable as a young *Mantis*. Pagenstecher's specimens at first would only eat plant-lice, but at a later stage of the development they devoured other insects greedily: the number of ecdyses is seven or eight. The ocelli appear for the first time when the wing rudiments do so; the number of joints in the antennæ increases at each moult. Dr. Pagenstecher considers that this insect undergoes its chief metamorphosis immediately after leaving the egg, the earlier condition existing apparently to fit the insect for escaping from the egg-case."

The young or nymphs which we reared we first fed on plant-lice, and later on with all sorts of small insects which we could sweep up from the grass with a net. At *c* and *c* in figure 12 are shown two nymphs which became adults at the next shedding of their skins. The nymphs have the same voracious and cannibalistic appetites as the adult insects. They are not difficult to rear from the egg if one keeps them supplied with living insects and isolated in individual

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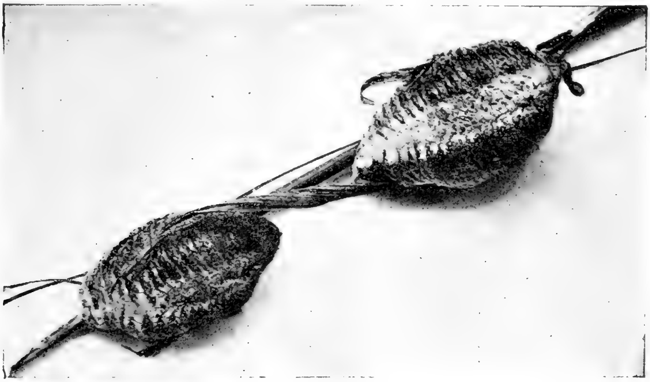
* We have made no careful observations on this point, but we doubt if the time they remain in this condition is more than a few hours, as Cockerell found in the case of a species of *Stagmomantis* in New Mexico (Am. Nat., 1898).

compartments or cages so they cannot devour one another. The nymphs get their growth during June, July and the early part of August, in New York.

HOW THE INSECT WAS INTRODUCED INTO NEW YORK.

It will never be definitely known just how or when this Praying Mantis was imported from Europe. It is very probable that we have to thank the nurserymen for its importation. They import millions of stocks from Europe every year, especially from France where this insect is very common; and Rochester is a great nursery center, more young trees coming to that city than to any other within the borders of the United States, says Mr. Rouse.



14.—*Egg-cases of the Common European Praying Mantis laid on a grass stem near Rochester, N. Y. It is probable that the insect was imported into America in egg-cases laid in a similar situation in Europe.*

It is possible for the insect to have been imported in the nymph or adult stage, but it is more probable that some egg-cases were attached to the stems of the straw or dried grass (see figure 14) used for packing material around the imported nursery stock; or possibly the eggs may have been attached to the branches of the trees. The insect must have come over five or more years ago to have become so numerous near Rochester. It seems strange that it has not been imported and become established before, either in the same or in some other locality in America.

At Rochester, the insect is geographically five or six degrees farther south than the northern limits of its range in Europe, and as the climatic conditions of New York are not very unlike those of France this beneficial insect can doubtless maintain itself in this country indefinitely, now that it has become well established.

A Similar Importation into Pennsylvania.

This common European Praying Mantis is not the first member of this interesting family of insects to be brought into this country from foreign lands and to have established itself here.

Three or four years ago a specimen or two of a large Mantid were found in the nursery of Thomas Meehan & Sons at Germantown, Pa. More specimens were taken in succeeding years and in 1898 it was announced (Ent. News, IX, 144) that the insect was a native of China and Japan, and bore the scientific name of *Tenodera sinensis* Saussure. As the Messrs. Meehan are constantly receiving plants from all parts of the world, the insect was doubtless introduced in the egg-state through this channel. Last year it was reported that there was no doubt that this large Oriental Mantid had gained a firm foothold in Meehan's nursery and was well established there.

Some Superstitions About Praying Mantes.

Writing of one of these insects in the 16th century, Mouffet says: "So divine a creature is this esteemed, that if a childe aske the way to such a place, she will stretch out one of her feet, and shew him the right way, and seldome or never misse." A Mrs. Taylor gives a most interesting account (Harper's New Month. Mag., xxiv, 491, 2) of a Mantid which she petted and named "Queen Bess." This Mantid was fastened to the bedpost by a silk thread and at night it would capture all mosquitoes which ventured near. Mrs. Taylor states that she was not naturally a superstitious woman, but some of the experiences she relates when she tested Queen Bess's prophetic capacity soon led her to obey the insect implicitly. She says she "never in one single instance knew her to refuse her opinion, and I never knew it to be wrong in whatever way she announced it." This Mantid disapproved by hanging her

head beneath her front legs, and approved by standing more erect and spreading and closing her wings. We hope our New York Mantid may possess this prophetic power!

From the great resemblance of many species of Mantids to the leaves of trees, some early travelers declared that they saw the leaves of the trees become living creatures and take flight; the Indians of Surinam in the last century are said to have believed that these insects grew like leaves upon the trees, and when they were mature, loosened themselves and crawled or flew away. Piso, in his works, states that Mantids "change into a green and tender plant, which is of two hands' breadth. The feet are fixed into the ground first; from these, when necessary, humidity is attracted, roots grow out and strike into the ground; thus they change by degrees, and in a short time became a perfect plant." What strange fancies, these!

Cowan (Curious Facts in the History of Insects, p. 83) states that "the Mantis was observed by the Greeks in soothsaying; and the Hindoos displayed the same reverential consideration of its movements and flight. But, in modern times, the superstition respecting the sanctity of the Mantis begins in Southern Europe, and is found in almost every other quarter of the globe, at least wherever a characteristic species of the insect is found. In many localities it is considered a great crime to injure the Mantis, and, at least a very culpable neglect not to place it out of the way of any danger to which it seems exposed." We hope this idea may prevail in the minds of school children and others who may be fortunate enough to meet our New York Mantis. Cowan further states that "the Turks and other Moslems have been much impressed by the action of the common *Mantis religiosa*, which greatly resemble some of their own attitudes of prayer. They readily recognize intelligence and pious intentions in its actions, and accordingly treat it with respect and attention, not indeed as in itself an object of reverence or superstition, but as fellow-worshipper of God, whom they believe that all creatures praise with more or less consciousness and intelligence.

"Other superstitions with respect to the Mantis are: When the Mantis kneels it sees an angel in the way, or hears the rustle of its

wings. When it alights on your hand you are about to make the acquaintance of a distinguished person; if it alights on your head, a great honor will shortly be conferred upon you. If it injures you in any way, which it does but seldom, you will lose a valued friend by calumny. Never kill a Mantis, as it bears charms against evil."

Finally, the monkish legends tell us that St. Francis Xavier, seeing a Mantis moving along in its solemn way, holding up its two forelegs as in the act of devotion, desired it to sing the praises of God, whereupon the insect carolled forth a fine canticle!

SOME SUGGESTIONS.

While this new addition to the insect fauna of America does not deserve to be revered by us as is apparently done in some parts of the Old World, yet, as it is decidedly an aid to man in his efforts to overcome his insect enemies, it should receive kind treatment, protection and thoughtful consideration. Its food consists almost entirely of other insects, and a large proportion of these are injurious species, like the grasshoppers, flies, etc. It will doubtless never attract much attention as a destroyer of injurious insects, yet it will materially help and thus deserve all the encouragement we can extend to it.

The curious creatures can often be kept alive in cages for a month or more, if well fed. Teachers will find a Praying Mantis a very interesting object lesson for Nature-Study, and its beneficial qualities should always be strongly emphasized. We would not advise that the children be encouraged to collect them, as the lesson they might learn from their cannibalistic or cruel ways could easily give them the wrong notion about Nature's ways; and our farmers and fruit-growers need the aid of every Praying Mantis that can possibly safely escape the vicissitudes of an insect's life, to help them in their warfare against injurious insects.

MARK VERNON SLINGERLAND.

Bulletin 186. **January, 1901.**

BOTANICAL DIVISION.

Cornell University, Agricultural Experiment Station,

ITHACA, N. Y.

IN CO-OPERATION WITH THE NEW YORK AGRICULTURAL EXPERIMENT STATION,
GENEVA, N. Y.

THE STERILE FUNGUS RHIZOCTONIA

As a Cause of Plant Diseases in America.

By B. M. DUGGAR and F. C. STEWART.

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THE STERILE FUNGUS RHIZOCTONIA AS A CAUSE OF PLANT DISEASES IN AMERICA.

Being a Preliminary Report upon the Occurrence of Diseases of Plants in America Caused by Different Forms of the Sterile Fungus Rhizoctonia.

By B. M. Duggar, Cryptogamic Botanist, Cornell University Agl. Exp. Sta., and F. C. Stewart, Botanist, New York Agl. Exp. Sta.

Introductory.

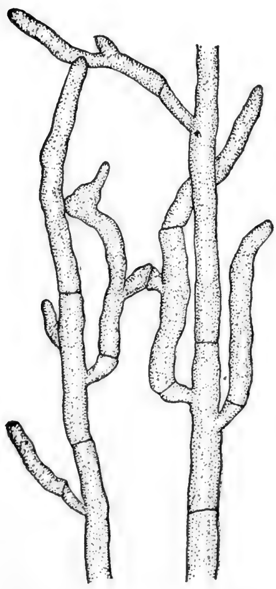
Studies on a beet root-rot and a carnation stem-rot in 1898 first drew the writers' attention particularly to the fungus *Rhizoctonia* as a cause of various plant diseases in this country. It needed no extended search to ascertain that this fungus is much more commonly associated with diseases of certain greenhouse and field plants than our economic literature would suggest. During the three seasons that our attention has been directed to this matter, the occurrence of *Rhizoctonia* on some entirely new hosts has been observed, and also upon other hosts new to America. As a preliminary report, it now seems well to bring the subject to the attention of American mycologists. Our work is directed towards a monograph including all known species of this fungus; and it is hoped that these notes will enlist the support of other workers, and some contributions of material.

Besides a brief historical and morphological account, this bulletin concerns itself merely with the presentation of some notes upon the occurrence and destructiveness of American forms observed by the authors. We reserve for the final paper all details of special morphology and physiology of the forms, as well as general matters of taxonomic interest and a discussion of European species. Nothing will at present be said of the limitations or identity of species.

The latter is a matter which must be determined largely by cross inoculations, together with morphological studies. Inoculation experiments have been in progress for two years, but they are not yet in shape to be fully reported; hence a presentation of the results will be deferred.

CHARACTERS OF THE FUNGUS.

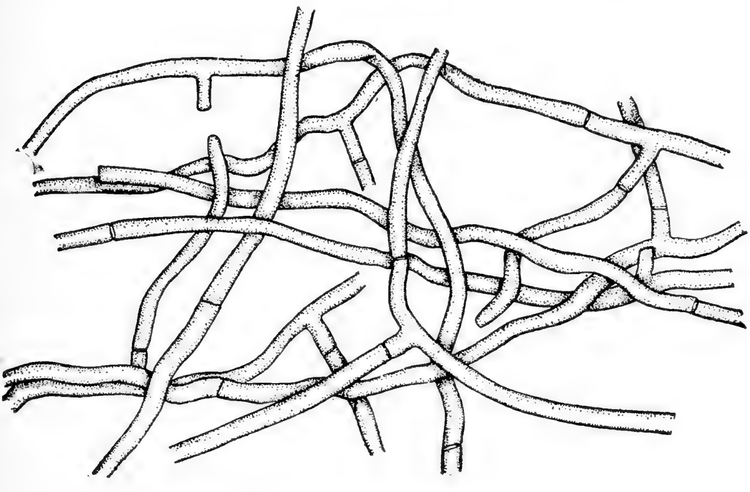
Rhizoctonia is a form genus established to include certain sterile fungi occurring upon the roots of plants. The members of this genus, however, may be readily located by certain distinguishing characters of the mycelium. In pure culture, moreover, a very characteristic form of growth is to be found. The young hyphæ growing in diseased tissue or in pure culture show a distinctive manner of branching; but as this character is in general the same for all, a description of the beet fungus will suffice for this account.



15.—*Young hyphæ of the Rhizoctonia.*

The young branches are inclined to the direction of growth of the parent branch at an angle more or less acute. And the former are somewhat narrowed or constricted where united with the latter, as in Fig. 15. At a distance of a few microns from these places of union, a septum is invariably formed. The young hyphæ are often strongly vacuolate; but later they usually become uniformly granular and more deeply colored. The branching also seems to have occurred more nearly at right angles to the main hypha, and the constriction at the place of union may not be so marked. (See Fig. 16.) On the beet root a short, tufted, or somewhat sporodochia-like growth of the mycelium may also occur. The hyphæ of these tufts are brown, closely septate, constricted at the septa, and often branching in an irregular or dichotomous fashion, as in Fig. 17. Such hyphæ may eventually break up into hyphal lengths

of a single cell or several cells in extent. The individual parts then seem to function as conidia, and germinate within a few hours when placed in suitable conditions. So far as observed, germination is always by the protrusion of a tube through a septum. When several cells are connected, a germ tube from one cell may pass into and through its neighbor, as in Fig. 18, and thus peculiar appearances may result. Some of the cells of the hyphal chain seem to be devoid of protoplasm, and from neighboring protoplasmic cells the germ tubes seem to pass into such empty cells as readily as directly into the nutrient solution. When the germ tube is from 10μ to 20μ in length, it is invariably narrowed towards the outlet from the



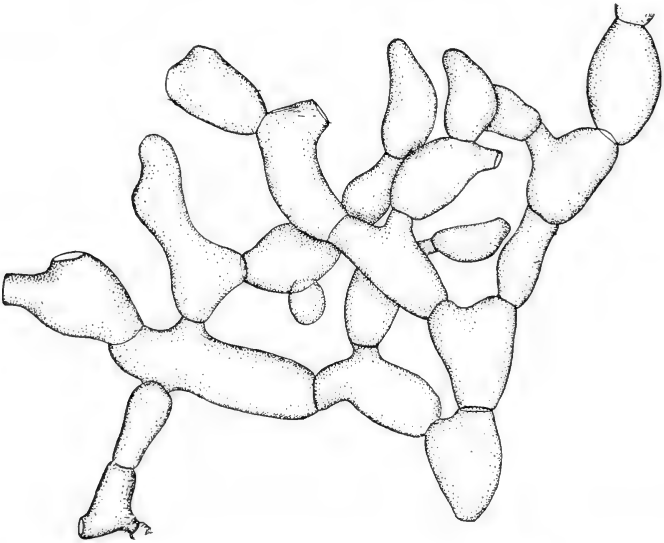
16.— *The brown hyphæ which invest the cracks on diseased beets.*

parent cell, and a septum forms at a short distance from this outlet, as in Fig. 18. Large, irregular, sclerotial bodies are sometimes found upon the beet, but they are by no means of constant occurrence.

If a part of a diseased beet is placed in a moist chamber, a loose mycelial growth soon appears, and the threads may grow out to the extent of half an inch or so. From this it is an easy matter to obtain a pure culture by transferring some of this mycelium to acidulated agar in petri dishes. The fungus grows readily upon acidulated agar, while bacteria are for the most part excluded. The fungus may then be transferred to bean pods, or beet plugs, in test

tubes, upon both of which media most forms of *Rhizoctonia* seem to grow well. In pure culture a loose mycelial growth first appears. This becomes brown in time. A short tufted growth may appear later; and usually there is also an effuse or crust-like sclerotial development. In culture the sclerotia are usually irregular in form and brown in color.

At this time it is not desired to enter into a discussion of the slightly different morphological characters which may distinguish the different forms of *Rhizoctonia*.



17. — *The large, closely septate hyphæ which make up the short tufted growth.*

BRIEF NOTES UPON RHIZOCTONIA IN EUROPE. *Historical.*

The root-destroying fungus *Rhizoctonia* was first discovered by De Candolle* in 1815. He named two species: *Rhizoctonia medicaginis*, occurring on *Medicago*, *Trifolium* and related hosts; and *R. crocorum*, a fungus destructive to crocus bulbs. Of the brief notes published upon other species of the fungus and other host plants until 1851, a comprehensive summary is given by the brothers Tulasne.† They believed that the several species then described

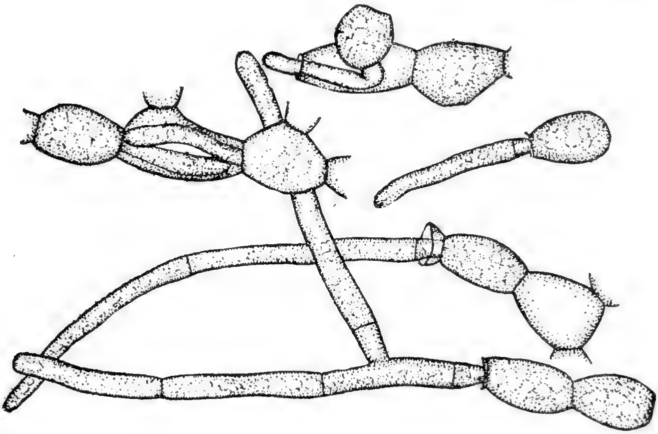
*De Candolle.—Mem. d. Mus. d' hist. nat., 1815.

†Tulasne, L. et C.—Fungi Hypogaei, pp. 188–195, 1851.

were not to be regarded as distinct, and all were thrown together under the name *Rhizoctonia violacea.* In 1858 Kühn* discussed more at length certain forms of economic importance, and made known some new hosts among agricultural plants. Fuckel† reported a perithecial form, *Leptosphæria (Byssothecium) circinans* and also a pycnidial form of *R. medicaginis* D. C. The only claim for the relationship of these forms was based upon their association in nature.

In a similar way other fungi have been subsequently suggested as perfect stages of *Rhizoctonia*, but evidence of genetic relationship is constantly lacking.

Among forms more recently described may be mentioned an oak root-fungus discovered by Hartig.‡ It was found closely associated



18.— *Germinating cells of the Beet Root-Rot Fungus.*

with the ascomycetous form *Rossellinia quercina*, so that the reported rhizoctonial stage was described under the latter name.

Scholtz§ has described *Rhizoctonea strobi*, causing a disease of the Weymouth pine, and he was unable to establish any connection between the hyphæ of this *Rhizoctonia* and those of certain fruiting forms found on plants killed by this disease.

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* Kühn, J.—Krankheiten der Kulturgewächse, Berlin, 1858.

† Fuckel.—Botan, Zeitung, **34**, 1861 (p. 250).

‡ Hartig, R.—Untersuch. aus d. forstbotan. Institut zu München, 1888.

§ Scholtz.—*Rhizoctonia strobi*, ein neuer Parasit der Weymouthskiefer. Verhandl. d. zoolog.-botan. Ges. Wien, **47**: 541–557, 1897.

Frank* has recently reported *R. violacea* as destructive to grape vines. A perfect form is reported which he names *Thelephora Rhizoctoniæ.*

Rostrup has also described *Rhizoctonia fusca*, the cause of a disease of turnips in Sweden. Comes, Sorauer and Frank have also given full general accounts of the European rhizoctonial diseases in their works on plant diseases.

The list of European host plants now covers a very wide range. The following are the most important plants affected: Alfalfa, asparagus, beet, carrot, various clovers, crocus, fennel, geranium, oak, onion, pine, potato and turnip. In all of the above the fungus is primarily a root parasite, and it will be seen that it occurs upon fleshy, herbaceous and woody roots.

RHIZOCTONIA IN AMERICA. *Historical.*

Neglecting for the present any such mentions of *Rhizoctonia* as have been made in "Lists of Fungi," or even brief technical descriptions of new forms, we find in American literature very little concerning *Rhizoctonia*. In 1891 Pammel† published some notes on beet diseases, and a beet root-rot was described which he considered due to *Rhizoctonia betæ* Kühn,‡ this fungus having been mentioned by Kühn, Eidam and others as an important beet disease in Germany.

In 1892 Atkinson§ found in Alabama a sterile fungus causing a damping-off of cotton, also called "sore shin." Later he found and described a similar fungus in connection with the damping-off of various seedlings under glass at Ithaca.‖

The above are the chief economic references to the occurrence of *Rhizoctonia* in America until the appearance of Bulletin 163 ¶

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* Frank B.— Ein neuer Rebenschädiger in Rheinhessen [Ref. Centrbl. f. Bakt. Parasitenk. u. Infektionskr., **4**, 781, Abth. II.]

† Pammel, L. H.— Bulletin 15. Iowa Agl. Exp. Sta., 1891.

‡ Kühn, J.— l. c.

§ Atkinson, Geo. F.— Some Diseases of Cotton. Bulletin 41, Ala. Agl. Exp. Sta., 1892, pp. 30–39.

‖ Atkinson, Geo. F.— Damping off. Bulletin 94, Cornell Univ. Agl. Exp. Sta., 1895, pp. 339–342.

¶ Duggar, B. M.— Three Important Fungous Diseases of the Sugar Beet. (See pp. 339–352.)

of the Cornell Experiment Station. In December, 1898, the writers presented a paper on *Rhizoctonia* to the Society for Plant Morphology and Physiology at its meeting in New York City. This paper, which was entitled "Different Types of Plant Diseases due to a common *Rhizoctonia*," was published only in abstract.* During the past year Stone and Smith† have published an account of lettuce *Rhizoctonia*, and some experiments on its treatment. In the succeeding pages we give our observations upon the occurrence of *Rhizoctonia* upon various plants in America.

ON THE BEAN, *Phaseolus vulgaris*.

Early in August, 1900, we received a few complaints of the ravages of what appears to be an undescribed stem-rot disease of beans. A field of about twenty acres of red kidney beans near Geneva was considerably injured by the disease. The plants were affected as follows: At a distance of from one to two inches above the surface of the soil there was a place on the stem where the tissues were dead and discolored. Frequently this occurred at the point where the plants commenced to branch. The dead part was dry-rotten clear to the pith, from one-half inch to one inch or more in length, and usually extended entirely around the stem. Being much weakened at the point of attack, it was a common thing for affected plants to be broken over by the wind. When this did not happen the whole plant slowly dried up and died.

Although larvæ were occasionally found in the diseased stems, it was plain that the trouble was not due to any insect. In all stages of the disease the affected parts were constantly filled with a species of *Fusarium* which, at that time, we suspected to be the principal cause of the disease. However *Rhizoctonia* hyphæ were also present in a great many cases. Sometimes the medulla of dead plants was completely filled with *Rhizoctonia*, and occasionally it was found in early stages of the disease; but it was not constantly present in quantity. The crop preceding the beans was corn.

From Phelps we received bean plants affected with the same dis-

* See Bot. Gaz., **27**: 129.

† Stone, G. E., and Smith, R. E.—The Rotting of Greenhouse Lettuce. Mass Exp. Sta., Bul. 69.

ease and some of them showed an abundance of *Rhizoctonia*. Mr. F. M. Rolfs* also reports having found *Rhizoctonia* on beans on Long Island.

Later, pure cultures from the Geneva material proved capable of producing disease in carnation plants, so that the fungus is very likely pathogenic.

Moreover, on at least two occasions, a *Rhizoctonia* has been found producing damping-off among seedling beans in the greenhouse. The disease is characterized by an ulceration of the stem at the surface of the soil and later prostration and death of the seedlings.

ON THE BEET, *Beta vulgaris*.

Our attention was first called to this disease by specimens of affected beets sent to us from Binghamton. A few days afterwards the disease was discovered as a beet trouble of considerable importance at Cattatonk, N. Y. This occurrence has been fully treated in Bulletin 163 of the Cornell Experiment Station, and at this time a summary of these notes will suffice. At Cattatonk a three-acre field was attacked so severely that fully one-third of the crop was lost. Diseased plants are usually found in scattered areas throughout the field; but the fungus undoubtedly passes readily from plant to plant in the row and it has a tendency to spread radially. Cold weather or dry conditions quickly retard the spread of the trouble, and it is much more abundant where the soil is moist or the surface drainage bad.

During hot weather the fungus secures a hold most readily at the bases of the leaves, perhaps because here there is moisture with the slightest rain or dew. Inoculation experiments also demonstrate that in these parts the disease "takes" well. The progress of the injury may be noted by the blackening of the leaf bases, and finally the wilting and prostration of the leaves themselves. The leaves do not, however, turn brown until after they have fallen. When the fungus has worked into the crown and root proper a browning of those parts is evident, and finally deep cracks may appear, as shown in Fig. 19.

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* Our thanks are due Mr. Rolfs, who has made a great many field observations for us.

19.— *A late stage of Rhizoctonia Beet-Rot, showing the cracking and rotting of the root.*

The brown mycelial threads of the fungus among the diseased leaf bases are evident to the unaided eye, and after the root has become affected, a considerable mycelial weft may be found in the cracks and affected parts. A diseased beet sliced lengthwise and placed in a moist chamber yields in a day or two a luxuriant growth of the fungus.

This disease has since been reported to us in the central and the western parts of the State, but specimens were not seen. During the past season it was found again, in the month of August, at Flint and at Phelps, N. Y.; but in neither case was there any serious outbreak of the disease. Specimens collected at the former place showed a considerable development of sclerotia, which bodies had not been previously observed upon the beet. Furthermore, Mr. A. D. Selby has kindly told us that he has found this disease of beets in Ohio during the past autumn.

Inoculation experiments have been made in the field, and these all indicate beyond a doubt that this *Rhizoctonia* may readily produce beet root-rot when the conditions are favorable. Moist conditions are essential for the spread of the disease from plant to plant. Morever, this fungus taken directly from diseased beets has the power of damping off lettuce and also beet seedlings.

A beet disease due to a species of *Rhizoctonia* has been known to botanists in Europe since 1855; and we are indebted to Professor Karl von Tubeuf, of Berlin, for material of that fungus. It is improbable that the American form is identical with the European. However, the disease found by Pammel* in Iowa may be the same as the one which we find in New York.

ON THE CABBAGE AND CAULIFLOWER, *Brassica oleracea*.

Specimens of diseased cabbage seedlings were received from Cairo, Ill., early in 1898. Among growers this disease is improperly called black rot. Sometimes the disease affects very young seedlings, and they are damped off by it, but it is more common after the plantlets have developed one or two true leaves. In the latter, ulcerated areas at or below the surface of the soil often characterize

* Pammel, L. H.— Loc. cit.

the disease. Plants set in the field are not known to be affected. An examination of the Illinois material showed that a *Rhizoctonia* was constantly present in abundance, and undoubtedly the cause of the trouble. *Rhizoctonia* has also been found causing a disease of cauliflower seedlings at Geneva. The plants were ulcerated at the bases of the stems, sometimes the entire cortex having disappeared.

On the Carrot, *Daucus carota.*

The hasty examination of a few carrot fields in August, 1900, resulted in the finding of a few plants affected with *Rhizoctonia.* In a field at Flint, N. Y., two specimens were found, and in another field near Phelps, N. Y., about a dozen more. In every case the plants were affected at the crown. The leaves were all dead, their bases being rotted off and thickly covered with Rhizoctonia hyphæ. About half an inch of the upper portion of the root was also rotten, but the disease showed no tendency to run down the root. In some of the specimens there were indications that the rot had been initiated by some larva boring into the crown of the plant.

Kühn* and others have reported the occurrence of *Rhizoctonia* on carrots in Germany, but we believe that up to the present time there is no record of the occurrence of such a disease in America.

On the Celery, *Apium graveolens.*

Our knowledge of the occurrence of *Rhizoctonia* on celery is confined to two cases in which it was the cause of a destructive damping off of celery seedlings. Both of these cases were observed in June, 1899. The first one occurred in one of the Station greenhouses at Geneva, and the other in a greenhouse at Poughkeepsie where celery plants were grown extensively. In the latter instance the owner stated that he had had much trouble from damping off. In both of these cases *Rhizoctonia* was undoubtedly the sole cause of the trouble. We are informed that the damping off of celery seedlings is a common occurrence, but thus far we have had opportunity to investigate only the two cases above mentioned.

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* Kühn, J.— Krankheiten der Kulturgewächse, p. 224.

ON THE COTTON, *Gossypium herbaceum.*

The *Rhizoctonia* which is the cause of "sore-shin" or damping off of cotton seedlings has not yet been secured by us; but Professor Atkinson has kindly put at our disposal drawings which he made while studying this fungus in Alabama. He first reported upon it under the caption "sore-shin" in Bulletin 41 of the Ala. Agl. Exp. Sta. In describing it, he says: "The diseased portion of the plant is just beneath the surface of the ground, and is characterized by a shrunken area of a dull reddish-brown color. * * * If the injury remains confined to the superficial tissues, the plant may, and frequently does, recover." The sterile fungus concerned with this disease was isolated, and inoculation experiments demonstrated that the fungus secured was the cause of the damping-off. The description of the fungus in the above mentioned bulletin and the drawings which we have, demonstrate beyond a doubt that the fungus is a form of *Rhizoctonia*.

ON THE LETTUCE, *Lactuca sativa.*

Since 1896 we have repeatedly found lettuce seedlings damping off by a sterile fungus; but it was not until 1898 that it was particularly studied, or its affinities ascertained, and the fungus located as *Rhizoctonia*. Lettuce seedlings affected by this fungus have much the same appearance as seedlings affected by any damping-off fungus. At or near the surface of the ground the tissues become water-soaked in appearance, they are unable longer to support the plantlet, and it falls prostrate on the surface of the ground, the fungus soon invading all parts. This fungus, under favorable conditions may wilt down and destroy, within a day or two, whole boxes of lettuce seedlings. The disease is also readily induced by using pure cultures of the fungus for inoculation purposes.

What is apparently the same fungus has been found several times as a disease of maturer lettuce plants. After the presentation of a preliminary report upon rhizoctonial diseases before the Society for Plant Morphology and Physiology in New York, December, 1898, we received from Mr. R. E. Smith, Amherst, Mass., lettuce plants showing a severe rotting of the leaves. There was no doubt about the characters of the fungus, and we determined it for Mr. Smith as

the *Rhizoctonia* of lettuce. From the characters of the parasitic material, as well as from pure cultures, we considered it identical with the damping-off fungus. The specimens received showed no rotting of the stem, the leaves being the seat of attack. On the older lower leaves the leaf blades alone are affected; but the more delicate inner leaves succumb entirely, blackening and decaying with the progress of the disease. Hyphæ* of the fungus occurred scantily over the leaf surface, and a short tufted growth might be found on the inner side of the petioles. These tufts were brownish-white or tawny in color and not so dark as the corresponding growth in culture.

During the past winter this fungus has also been found by Mr. Rolfs on greenhouse lettuce plants at Rochester.

Again, Atkinson† found a form of the sterile fungus studied by him in Alabama, causing damping off of lettuce seedlings at Ithaca.

Occurring, then, in such widely separated regions it is very probable that it is a fungus very generally distributed.

ON THE POTATO, *Solanum tuberosum*.

Although a Rhizoctonia‡ disease of potatoes has long been common in Europe, especially in Germany, where it is known under the names "Grind" and "Pockenkrankheit," there is, so far as we are able to ascertain, no record of the occurrence of *Rhizoctonia* on the potato in America. Yet our observations indicate that potatoes in the United States may be quite generally infested by a species of *Rhizoctonia*, as the subsequent discussion will demonstrate.

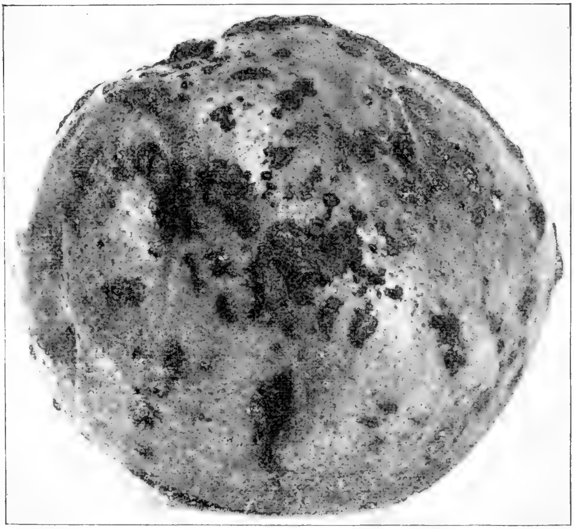
The occurrence of this fungus upon potatoes was first brought to our attention by Messrs. F. A. Sirrine and F. M. Rolfs, who reported having found it on potato stems collected in the vicinity of Jamaica on Long Island. In the latter part of July the writers visited Long Island and examined several potato fields in the vicinity of Jamaica and Floral Park. A little *Rhizoctonia* was found on the potato stems in all of the fields examined, but it was

* Compare Stone, G. E., and Smith, R. E.—The Rotting of Greenhouse Lettuce, Bulletin 69, Mass. Agl. Exp. Sta. (Hatch), p. 16–17, 1900.

† Atkinson, Geo. F.—l. c.

‡ *Rhizoctonia solani*, Kühn.

impossible to determine whether the plants had suffered any injury from its presence. Unfortunately, the potato tops were nearly all dead at that time, the varieties grown in that locality being almost all early varieties. A few tubers were examined but nothing found. On this visit we also had the opportunity of examining some diseased potato stems collected on Staten Island by Miss Emma Sirrine, and found them infested with *Rhizoctonia.* A few days later Mr. Rolfs found it at Mattituck, Cutchogue and East Hampton, in the eastern part of Long Island. Here it occurred on late potatoes,



20.—*A potato tuber showing the sclerotia of the Rhizoctonia.* (⅞ *natural size.*)

and, in one instance at least, there was good evidence that it had killed a considerable number of plants. It was also found at Wading River. There has been much complaint about the premature dying of potatoes on Long Island the past season. What part *Rhizoctonia* played in this trouble is not certainly known, but probably it was not an important one. Later, the *Rhizoctonia* was found on potato stems in many fields about Geneva, Phelps, Lodi and Oaks Corners.

On August 3 while peeling some scabby potatoes for potato agar

we observed that some of the so-called "deep scab" ulcers were filled with mycelium composed of rather coarse hyphæ. Microscopic examination showed the hyphæ to be those of *Rhizoctonia*. These tubers had been bought at a grocery in Geneva. Other tubers were then obtained from other groceries and also direct from potato fields in the vicinity of Geneva, and it was found that *Rhizoctonia* hyphæ are of frequent occurrence in scab ulcers.

The next advance made was the discovery of the *Rhizoctonia* sclerotia on the tubers and stems. On September 21 Mr. Rolfs found, in a potato field near Geneva, a tuber bearing a few sclerotia of *Rhizoctonia*. The following day the field was revisited and carefully searched. The crop had been harvested several days earlier, and in the interval rain had washed the dirt from such tubers as had been overlooked and also from the stems of the plants which were left in the field. This facilitated the search and we soon gathered about 30 tubers bearing sclerotia. See Fig. 20. Then we began looking for sclerotia on the stems and had little difficulty in collecting about 25 good specimens. One of these is shown in Fig. 21. Having once seen the sclerotia on the tubers it was easy to find them on almost every lot of tubers examined. We found them, oftentimes in great abundance, on tubers offered for sale at the groceries in Geneva, Poughkeepsie and Ithaca. A wagon load of potatoes offered for sale at Ithaca was so completely overrun with *Rhizoctonia* that it is doubtful if there could have been found in the entire load a single tuber which did not bear one or more sclerotia. Some of the tubers showed several hundred sclerotia each. These tubers were of the variety Rural New Yorker No. 2; and in other respects they were fine, being of large size and almost entirely free from scab and rot. They were grown at Slaterville, near Ithaca. A load of potatoes on the streets of Sayre,

21.—*Rhizoctonia sclerotia on a potato stem. (Natural size.)*

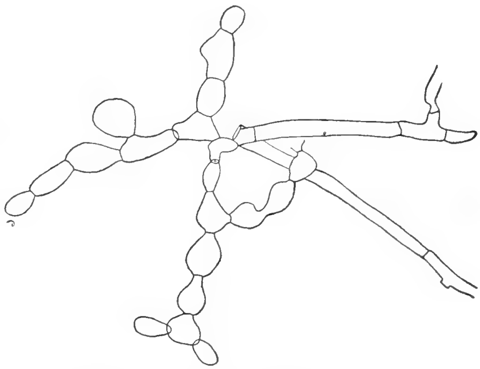
Penna., was examined and found to contain a considerable number of tubers bearing sclerotia. We have also seen the sclerotia on tubers grown at Mattituck and Cutchogue. Mr. A. D. Selby has sent us from Wooster, Ohio, potato stems and tubers bearing *Rhizoctonia* sclerotia, showing that the fungus exists in that State. Specimens have also been received from Prof. J. F. Duggar, Auburn, Ala., Mr F. M. Rolfs, Fort Collins, Colo., and Mrs. F. C. Stewart, who found it at Bassett, Iowa. In short, during the past season many observations on potatoes have been made in different parts of New York State, and *Rhizoctonia* has almost always been found in greater or less abundance. Moreover, it occurs in Alabama, Colorado, Iowa, Ohio and Pennsylvania, and is probably very generally distributed. Recently the sclerotia have been found abundantly in the markets of Washington, D. C., on New York and Michigan potatoes, and also to a slight extent on one variety of potatoes grown in Maryland.

We have the following proof that the *Rhizoctonia* disease of potatoes existed at Ames, Iowa, as long ago as 1890. In the summer of 1890 Mr. F. A. Sirrine, at that time Assistant Botanist at the Iowa Experiment Station, investigated a potato disease which was doing serious damage on the Station farm. He found the subterranean parts of the affected plants covered with a certain fungus which he at once suspected of being the cause of the trouble. He was unable to identify the fungus. In the course of the investigation an important insect enemy of the potato, the potato-stalk weevil, was discovered* in connection with the disease, and as it appeared that this insect was responsible for at least the greater part of the trouble, attention centered upon it and the fungus was allowed to pass into oblivion. Fortunately, Mr. Sirrine made and preserved a cameralucida pencil drawing of the fungus. This drawing shows that the fungus studied by Mr. Sirrine was undoubtedly a *Rhizoctonia.* We have inked in the drawing, without altering it in the least, and publish it herewith. See Fig. 22.

The *Rhizoctonia* attacks only the subterranean parts of the potato plant. The hyphæ occur in the medulla, where they are for the

*See Iowa Exp. Sta. Bull. 11: 490.

most part very slightly, if at all, colored, and on the outside of the stem and on the roots, where they are often light brown in color. When the hyphæ occur in scab ulcers, those near the surface are brown, while the deeper-lying ones are colorless. The sclerotia on the stems and those on the tubers are essentially the same. They are irregular in outline and vary in size from a mere speck to the size of half a pea or even larger. When dry they are dirt colored, and it is difficult to distinguish them from particles of soil adhering to the tubers. This probably accounts for their having been so generally overlooked. But when wet they become dark brown and very conspicuous, particularly on the light skinned varieties of potatoes. In spite of vigorous washing, sufficient to thoroughly remove the soil from the tubers, the sclerotia remain firmly attached. Two housekeepers whose attention we have called to the matter assure us that they have long observed that when potatoes are prepared for baking there are often found dark brown irregular bodies which are exceedingly difficult to remove by washing. It is necessary to use a scrubbing brush to get rid of them. We suspect that these sclerotia are well known to many of the more observant housekeepers.



22.—*Hyphæ of the potato Rhizoctonia; from drawing by Mr. Sirrine.*

The amount of damage done by the *Rhizoctonia* when it attacks the subterranean stem and roots of the potato is as yet undetermined, but that the fungus is, in some cases at least, a parasite there is little doubt. Where it occurs on the tubers, all of our numerous observations go to show that it is not injurious to them. While the *Rhizoctonia* hyphæ may be abundant in scab ulcers there is no evidence that they have anything to do with the formation of the ulcers. The sclerotia are usually seated on the uninjured skin of

the tuber. A tuber may bear hundreds of sclerotia and yet be absolutely sound. In this respect our *Rhizoctonia* appears to differ from the European potato *Rhizoctonia.* Some writers report that the latter is a common cause of potato rot. In other respects the two forms are strikingly similar. We are under obligations to Prof. Dr. Paul Sorauer, of Berlin, for excellent fresh specimens of the European *Rhizoctonia solani*, from which cultures for inoculation work have been obtained.

ON THE RADISH, *Raphanus sativus.*

In the winter of 1898 diseased radish plants of marketable size were received from Saratoga, N. Y. The disease consisted of a soft rot of the crown, or of large ulcerations in this region. As a rule, the leaves were unaffected until a considerable portion of the root had decayed. It was reported, however, that plants in all stages of growth were affected and killed. It proved to be a trouble of considerable importance with forced radishes, and nearly half of the crop was lost from this disease. It spread rapidly from plant to plant in the row, and from well-established centers of infection. When the material was received, the tissues surrounding diseased areas were infested with hyphæ of a *Rhizoctonia.* These hyphæ were also very abundant superficially, growth being induced, perhaps, by the moist conditions under which the plants had been kept. A culture of the fungus was secured, and with half grown radishes kept under moist conditions the disease was induced; but only a few plants were involved in this experiment. Unfortunately, this culture was afterwards lost, and it has not since been observed as a disease of mature plants. Nevertheless, *Rhizoctonia* has been found occasionally in the greenhouse as a radish damping-off fungus of slight importance.

ON THE RHUBARB, *Rheum rhaponticum.*

For several years a peculiar disease of rhubarb has been observed on Long Island; but until the past season no satisfactory cause of the trouble was evident. During July several rhubarb fields were visited in the vicinity of Jamaica, and in many of these the leaves were dying rapidly, the plants being in an unthrifty condition.

There was little or no injury due to the leaf-spot fungus, *Phyllosticta rhei*, and the trouble was evidently of other origin. Affected leaves became dried and shrunken in appearance, and soon fell to the ground. Where a field was badly affected, the majority of hills would show the trouble to the extent of at least a leaf or two. In several instances, apparently from one-fourth to three-fourths of the leaves were already dead. Fields thus affected showed noticeable injury even from a considerable distance.

Close by an affected field, or sometimes even contiguous to it, might be found a field showing the trouble only to a very slight degree. This may have been due to a longer culture of the rhubarb upon one than upon the other area.

An affected leaf breaks off readily just beneath the surface of the ground, and it was found that dead or prostrate leaves had rotted off in this region. The general appearance reminded one strongly of the effect of *Rhizoctonia* upon beets. There was very little superficial mycelium visible to the unaided eye. Microscopic examination showed hyphæ of a *Rhizoctonia* both superficially, and also immediately under the surface where the leaves were rotting. No other fungus was at any time found abundantly associated with the disease, and the *Rhizoctonia* was quite constantly present.

ON ORNAMENTAL ASPARAGUS, *Asparagus sprengeri*.

In May, 1900, a florist on Long Island called our attention to dead patches in a large bench of *Asparagus sprengeri* in one of his greenhouses. The plants were dead and the leaves, which were gray and dry, had a tendency to cling to each other. Closer observation showed that the leaves were bound together with brown threads which proved to be Rhizoctonia hyphæ. The disease seemed to be unimportant, being confined to small areas where the foliage was kept unduly wet by the dripping of water from the glass above. The roots of the affected plants were not examined. Pure cultures of the fungus have been secured.

Knowing that, in Europe, the garden asparagus, *A. officinalis*, is affected by a Rhizoctonia* root-rot we visited Mattituck, Long Island, for the purpose of searching for the *Rhizoctonia* in the

* *Rhizoctonia violacea* Tul.

extensive asparagus fields of that locality. Owing to unfavorable weather the search was not as thorough as it should have been, but we failed to find any indications of the presence of *Rhizoctonia* on asparagus roots.

For excellent specimens of the European fungus on the last named host we are also indebted to Prof. Sorauer.

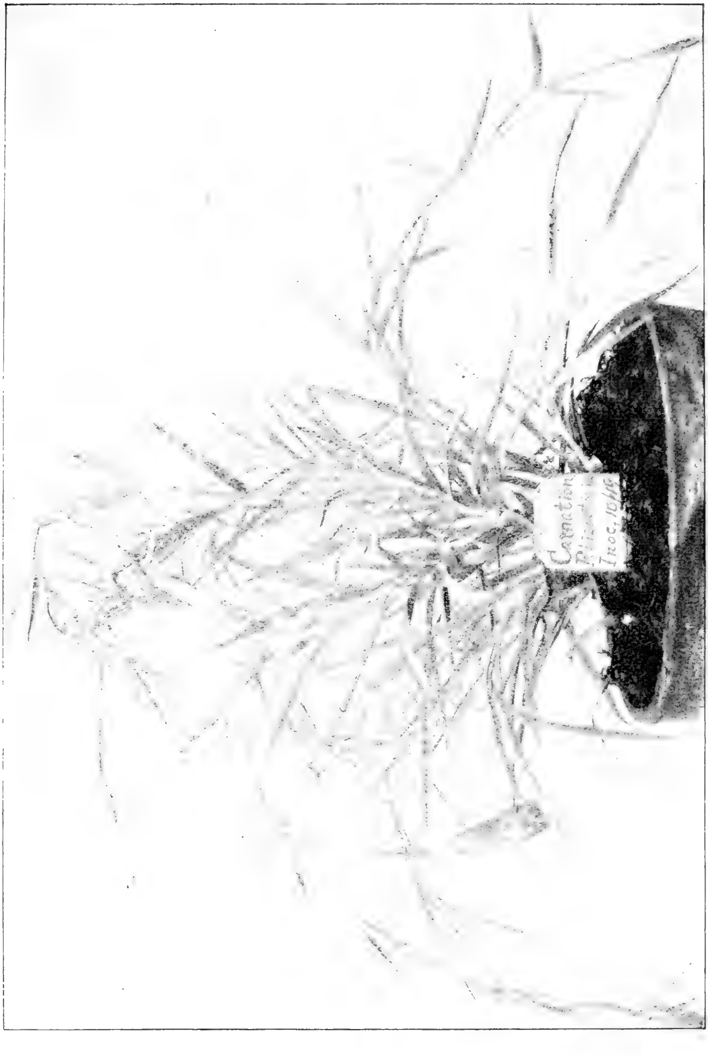
On the China Aster, *Callistephus hortensis*.

In the summer of 1899, Mr. Murrill received from a correspondent specimens of diseased China asters. From his notes we find that the plants presented a wilted appearance, but he observed no fungus either upon branch or leaf. As described by the gardener, the disease might well have been due to a *Rhizoctonia*. An examination of a specimen preserved showed that the lower part of the stem was considerably permeated with hyphæ of a *Rhizoctonia*. The fungus threads were also present superficially, and small crust-like sclerotiă had formed upon the stem. There is as yet no further evidence that the fungus found was the cause of the disease. A pure culture of the *Rhizoctonia* was, however, secured, and the fungus will be tested.

During the present season, China asters collected by Mr. Rolfs at Border City, N. Y., also showed a *Rhizoctonia* associated with an aster stem disease. Particular stress cannot be put upon this matter until inoculation experiments are made, for there seems to be at least one other stem disease of asters due to another fungus.

On the Carnation, *Dianthus caryophyllus*.

The carnation is subject to a very destructive Rhizoctonia disease known to florists by the name of stem-rot. Affected plants wilt suddenly, take on gray green color, and are soon dead and dry. The seat of the trouble is found to be in the stem at or just below the surface of the soil. The cortex on this portion of the stem is soft rotten and separates readily from the wood. The medulla is rotten and both medulla and cortex are filled with the hyphæ of *Rhizoctonia*. Not infrequently large, brown, irregular sclerotia are found attached to the subterranean portion of the stem and occasionally to the roots.



23.—*A carnation affected with Rhizoctonia Stem-Rot.*

That *Rhizoctonia* is the cause of this carnation stem-rot has been proven conclusively by inoculation experiments with pure cultures repeated many times. Fig. 23 is from a photograph of a carnation plant killed by artificial inoculation with a pure culture of *Rhizoctonia.* It presents the symptoms typical of the Rhizoctonia stem-rot disease.

This stem-rot* is one of the most troublesome of the carnation diseases and probably occurs throughout the whole United States wherever the carnation is grown. Frequently entire houses of mature plants are destroyed by it. During the past autumn it appears to have been unusually prevalent. It attacks plants of all ages both in the field and in the greenhouse, and is one of the principal causes of the damping off of carnation cuttings. In greenhouse benches it spreads slowly through the soil from one plant to another; but according to our experiments never through the air, as from one bench to another. Its principal mode of dissemination is by means of affected plants and cuttings.

ON THE SWEET WILLIAM, *Dianthus barbatus.*

Since *Rhizoctonia* is an active parasite on the carnation, it is to be expected that it attacks the closely related *Dianthus barbatus*, and such appears to be actually the case.

November 5, 1900, we had the privilege of examining a badly diseased plat of about 1,600 plants of *Dianthus barbatus* at Queens, Long Island. In the course of the season about 90 per cent of these plants had died from a sort of stem-rot. Several of the dead plants were not completely dry at the time of our visit, so it was possible to get some idea of the nature of the disease and its cause. The symptoms were strikingly like those of the *Rhizoctonia* stem-rot of carnations. The leaves had a sickly, yellowish color and were perfectly limp. The main stem and its numerous branches were soft-rotten at the surface of the soil, so that when an attempt was made to pull an affected plant it broke off readily at that point,

* There is a somewhat similar and destructive *Fusarium* stem-rot of carnations. See Sturgis, W. C. Twenty-first Ann. Rep. Conn. Agr. Exp. Sta. (1897): 175–181; Prillieux et Delacroix. Compt. Rend. de l' Acad. Science, **129**: 744–745; and Stewart, F. C. Bot. Gaz., **27**: 129–130.

leaving the main stem in the ground and many separate branches in the hand. The basal portions of these branches were disintegrated, the wood elements being separated from each other as if the tissues had been macerated.

The rotting stems contained an abundance of *Rhizoctonia*, various other fungi and nematodes, which latter are, of course, expected to occur in tissue so much decayed. Although not yet tested by inoculation experiments, the indications are that *Rhizoctonia* killed the plants.

It is of interest to note that the plat in which the plants were growing had been planted with carnations in the season of 1899, and they are said to have suffered considerably from *Rhizoctonia* stem-rot.

ON *Coreopsis lanceolata.*

Next to the plat of Sweet Williams above mentioned there were two rows of *Coreopsis lanceolata* which, so the owner informed us, had been considerably diseased during the summer. Only a few of the plants were killed outright, but from many of them the lower leaves had rotted away. The rot seems to start in the base of the petiole where it comes in contact with the soil. The decaying leaves were overrun with *Rhizoctonia*, but what relation the fungus bore to the disease can only be conjectured.

ON THE VIOLET, *Viola odorata.*

In October, 1899, two diseased violet plants were sent to us from Little Falls, N. Y. Both of these plants showed *Rhizoctonia*, leading to the suspicion that violets also are attacked by this fungus; but when a personal examination of the afflicted violet house was made not another case of *Rhizoctonia* could be found. The trouble was caused by *Glœosporium violæ.* Moreover, the two Rhizoctonia-infested plants were potted and placed in one of the Station greenhouses where they thrived and never after showed any ill effects from the presence of the *Rhizoctonia.*

About a year after this experience interest in the violet *Rhizoctonia* was revived by Mr. Rolfs' discovery of a case of destructive violet stem-rot in a greenhouse at Geneva. Here the affected plants were abundantly infested by *Rhizoctonia.* At about the same time

we found it on violets at Floral Park. The plants were in small pots. Some of them had stem-rot, while on others only the bases of the petioles were rotten. The rotten parts frequently contained *Rhizoctonia*.

Thus it appears that *Rhizoctonia* occurs not infrequently on violets, but whether as a parasite or only as a saprophyte can not now be stated.*

OTHER HOSTS.

In addition to the occurrence of *Rhizoctonia* as an apparent cause of diseases of the host plants already mentioned, there are several other plants upon which we have occasionally found this fungus. For the sake of brevity, we will condense the observations upon these, and bring them together under a single heading, deferring their more extended discussion until further observations and studies have been made upon them.

Rhizoctonia has been found on the roots and trunk of a dead cherry tree from Wright's Corners; as a damping-off disease of white pine and cucumber seedlings; on damped-off cuttings of begonia, coleus, verbena, hydrangea, hardy candytuft, and mammoth sage at Floral Park, N. Y.; on mature plants of phlox and pyrethrum at Floral Park; and on young plants of snap dragon at Geneva. Mr. Rolfs has observed it on the raspberry, lamb's quarters (*Chenopodium album*), tumble weed (*Amarantus albus*), pigweed (*Amarantus retroflexus*), and on decaying squash stems at Geneva.

PARASITISM OF THE FUNGUS.

In many cases *Rhizoctonia* is truly parasitic, and there can be no question about its being the cause of the diseases with which it is associated. The diseases of beet, carnation, lettuce, and some others with which we have experimented may be readily induced by merely placing in contact with the plant pure cultures of the fungus; and in time infection will result, provided there is sufficient moisture. Infection results more readily with the carnation by direct insertion of bits of the fungus into the plant. In other cases

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* Violet stem-rot is a complex disease not well understood. The fungus *Thielavia basicola* Zopf is generally accepted as being the cause of it. See Thaxter, R., Fifteenth Ann. Rep. Conn. Agr. Exp. Sta. (1891): 166–167.

where the fungus is associated with disease, we have as yet no proof that *Rhizoctonia* is the chief or even partial cause of the trouble. It may sometimes be associated with other fungi, perhaps *Fusarium*. Atkinson * has indicated that the sterile damping off fungus of cotton may perhaps have a part to play in the *Fusarium* disease of cotton, at least in initiating the disease.

In spite of the fact that *Rhizoctonia* is at times an effective parasite, the fungus is probably capable of protracted existence upon decaying organic matter in the soil. In this way it may be able to propagate itself, and to spread from plant to plant in the soil even when culture or other means fail to disseminate it. In fact, it seems to be of very general occurrence in the soil, and is likely to be quite commonly found in propagating beds as a cause of damping-off among cuttings and seedlings. From our experience thus far, we venture to predict that few forms of this fungus will be found very selective as to host, and one may well search for it upon the common weeds. The occurrence of this fungus as a disease producing organism is largely dependent upon the conditions, and when by excess of moisture or of heat the plant is placed at a disadvantage, or the fungus favored, the disease is likely to occur.

MEANS OF PREVENTION.

Little can be said at present concerning special means of prevention to be adopted for Rhizoctonia diseases. Plants growing under the most favorable conditions of moisture, temperature, and nutrition will probably show marked resistance to the attacks of such diseases, so that good sanitary conditions are of the first importance. An excess of moisture and the presence of freshly decaying plant products in the soil will unquestionably favor the disease. Particularly in the propagating and forcing benches is a frequent change of soil advisable. The fungus grows well upon acid media, and liming of the soil is therefore well; but this of itself is not thoroughly effective. If the fungus should become a serious pest in greenhouses, it may sometimes prove practicable to sterilize the soil with steam or with hot water.

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* Atkinson, Geo. F. Some Diseases of Cotton. Ala. Agl. Exp. Sta., Bulletin 41, p. 28.

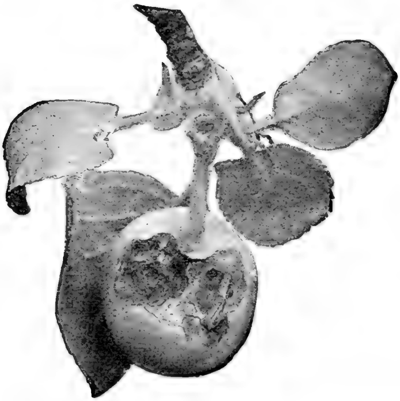
Bulletin 187. **January, 1901.**

Cornell University Agricultural Experiment Station.

ITHACA, N. Y.

ENTOMOLOGICAL DIVISION.

THE PALMER--WORM.



"*That which the palmer-worm hath left hath the locust eaten; and that which the locust hath left hath the canker-worm eaten; and that which the canker-worm hath left hath the caterpillar eaten.*"—JOEL, I., 4.

By M. V. SLINGERLAND.

PUBLISHED BY THE UNIVERSITY,

ITHACA, N. Y.

1901.

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CORNELL UNIVERSITY,
ITHACA, N. Y., *Jan.* 14, 1901.

HONORABLE COMMISSIONER OF AGRICULTURE, ALBANY, N. Y.:

SIR.— This bulletin, No. 187, prepared by Prof. M. V. Slingerland, embodies the results of his investigations and studies of the Palmer-Worm. It appears to me that the work has been done with care and that this bulletin will be of great value to fruit-growers and others.

This insect is a striking illustration of the "ups" and "downs" of an insect's life. Some of our great-grandfathers may have suffered from its ravages in the latter part of the eighteenth century. Then its "down" period lasted until the orcharding days of our fathers in the middle of the nineteenth century, and again the pest remained in obscurity for nearly another half century, so that it was virtually a new and unfamiliar insect to most orchardists when it appeared in great numbers in New York the past season. Prof. Slingerland has found that the Palmer-Worm presents a very vulnerable point of attack, and he sees no reason why it should not readily succumb to our modern methods of spraying for fruit pests.

The diffusion of such facts as are embodied in this bulletin will be highly beneficial to all who are interested in raising fruit or trees of any kind for the worm is not choice about its food. If we can judge the future by the past we may confidently expect that in a few years the pest will have disappeared or at least will have become so reduced in numbers that it will be of little economic importance. The report is submitted for publication under Chapter 430 of the Laws of 1899.

Very sincerely yours,

I. P. ROBERTS,
Director.

THE PALMER-WORM.

Ypsolophus pometellus Harris.

Order Lepidoptera; superfamily Tineina.

Why are many injurious insects much more abundant and destructive in some years than at other times? That most insect pests do have these "ups" and "downs" in their lives, is a well-known fact; but often the question cannot be satisfactorily answered, and rarely can one predict when any insect may appear in unusual numbers. Doubtless variations in climatic conditions, and in the number of their parasitic insect and fungous enemies, are the principal factors which bring about these "up" and "down" periods in the lives of injurious insects. Usually the army-worm is noticeably destructive for only one season in the same locality, and many years may elapse before it again attracts the notice of farmers. The tent-caterpillars and canker-worms have now been unusually abundant for several years in New York, but sooner or later the "down" period will come and the forest species especially may remain in obscurity for many years, as it did before its present "up" period.

We have prefaced this bulletin with these apparently irrelevant remarks because the insect to be discussed is the most striking illustration of the "ups" and "downs" of an insect's life with which we have met. Some of our great-grandfathers may have suffered from its ravages in the latter part of the 18th century, then its "down" period lasted until the orcharding days of our fathers in the middle of the 19th century, and again the pest remained in obscurity for nearly another half century, so that it was a new and unfamiliar insect to most orchardists when it suddenly appeared in great numbers the past season.

Beginning about June 15th, 1900, and continuing for nearly two weeks, our daily mail included two or three letters about the ravages of a new caterpillar in apple orchards. As soon as specimens of

these new depredators reached us, we found that they were unlike any orchard pests with which we were familiar, and we could only guess, after examining the literature, that they were what are now popularly known as *palmer-worms.* Breeding experiments in our cages soon showed that we had guessed correctly.

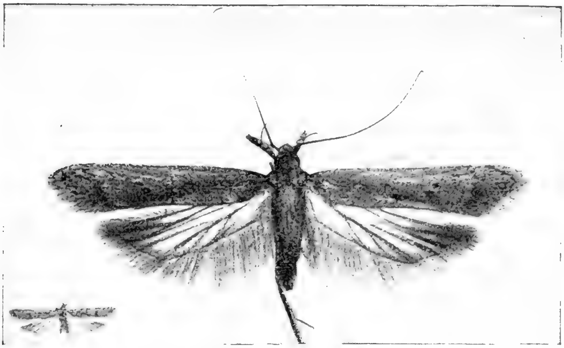
WHAT ARE PALMER-WORMS?

Historical notes.— A *palmer* is, briefly, a pilgrim or wanderer, and for more than three centuries the word has been used in connection with *worms* to popularly designate certain kinds of caterpillars. Just what insects are meant by palmer-worms in the Bible (see title-page, and also Joel, ii., 25, and Amos, iv., 9) is not known, but it is thought they were some kind of a caterpillar, possibly a measuring-worm. In the 16th and 17th centuries the name was aptly applied in England to certain hairy caterpillars, like our "yellow-bear," which are often found wandering about.* Unfortunately this apt application of the name seems to have fallen into disuse, as we fail to find it thus used in the entomological literature of the past 50 years; and yet all the recent, larger dictionaries give this definition of palmer-worms first place.†

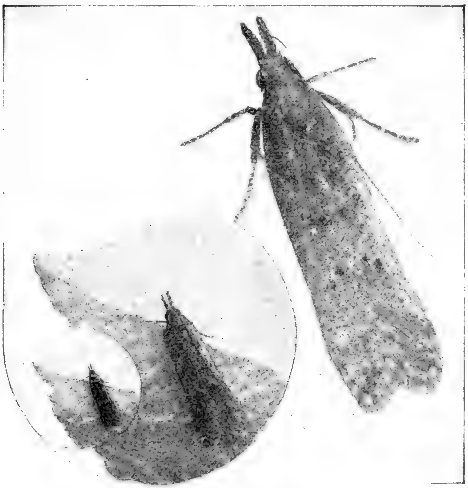
The name has been in use in America for nearly 250 years. During the latter half of the 17th century the early settlers in New England suffered much from the ravages of insects in their field crops and in orchards. "Much prayer there was made to God about it with fasting in divers places," says Winthrop. What are

* This fact is thus quaintly related by Topsell in his curious old *History of Serpents* (p. 105), published in 1608: "There is another sort of these caterpillars, who have no certain place of abode, nor yet cannot tell where to finde their food, but like unto superstitious pilgrims, do wander and stray hither and thither, and (like Mice) consume and eat up that which is none of their own: and these have purchased a very apt name amongst Englishmen, to be called Palmer-worms, by reason of their wandering and roguish life, (for they never stay in one place, but are ever wandering) although by reason of their roughnesse and ruggednesse, some call them Bear-worms. They can by no means endure to be dieted and to feed upon some certain herbs and flowers, but boldly and disorderly creep over all, and taste of all plants and trees indifferently, and live as they list."

† The Standard Dictionary gives as a third definition of palmer-worm: "The grub of any destructive beetle, as a weevil." We have failed to find any hint elsewhere of this use of the name.



23.— *Palmer-worm moth, enlarged; natural size in lower corner.*



24.— *Palmer-worm moth at rest, from life. Two different enlargements, and natural size in lower left-hand corner.*

now known as army-worms, grasshoppers, canker-worms, cicadas and tent-caterpillars were the principal depredators. But in those days they were variously and indiscriminately named canker-worms, palmer-worms and caterpillars.* As the ministers during those years of devastation by droughts and insects, made much homiletic use of the passage from Joel (see title-page) it is no wonder these familiar names were thus often and indiscriminately applied. This confusion of these names continued for many years, in fact, it was not until about 1800 that the name *canker-worm* and *palmer-worm* were restricted to certain insects and given their present signification in the United States.

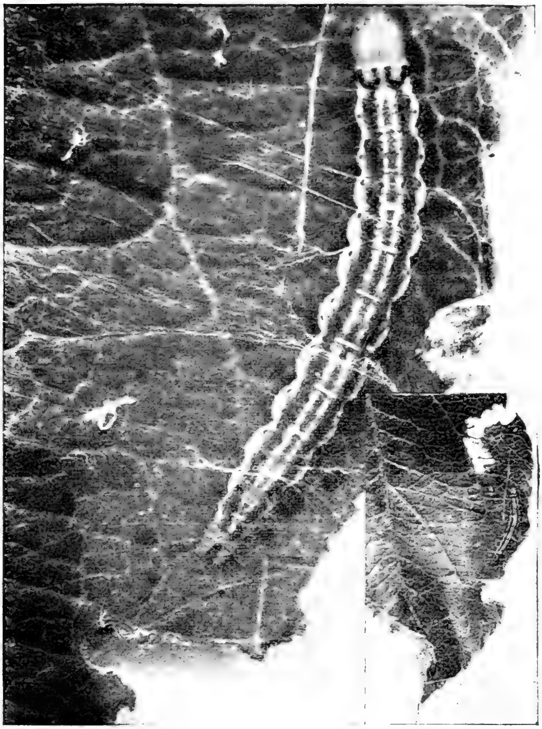
Present application of the name.— So far as we can glean from the world's entomological literature the name *palmer-worm* is not in common use anywhere to designate any particular kind of an insect, except in the United States, where it has become restricted to one of the small moths or Tineids whose little caterpillars work on trees in much the same manner as canker-worms. The special characteristics of this little insect pest will now be considered.

CHARACTERISTICS OF THE PALMER-WORM.

This insect passes through four distinct stages during its life-cycle — the *egg* from which hatches the *larva* or *caterpillar*, which transforms through the *pupa*, into the *adult* or *moth*. As one is not likely to meet with the egg or pupal stages of the insect, only the caterpillar or palmer-worm stage and the moth will be described here.

The caterpillar or palmer-worm.— The pest does all of its destructive work in this stage of its life. Even when full-grown, this palmer-worm is quite a small, slender caterpillar, measuring only about half an inch in length; it is shown natural size in the apple on the title-page and in the lower corner of figure 25. Its

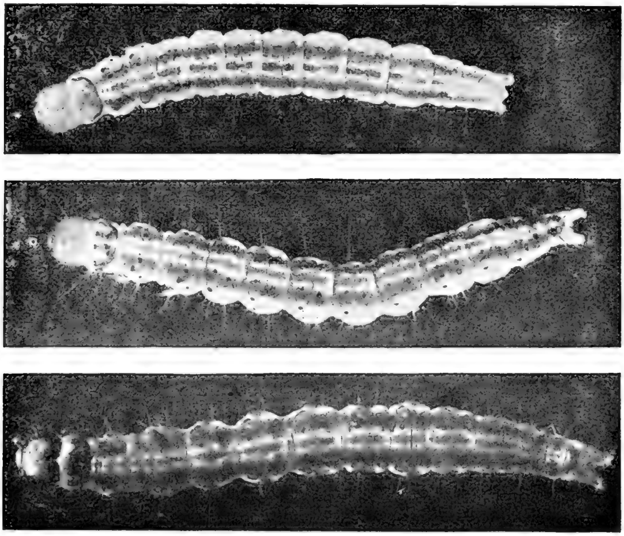
* The name *canker-worm* was used as early as 1661 (Hull's Diary, in Trans. Am. Antiq. Soc., III., 203) to designate the caterpillars now known by that name. The earliest use of *palmer-worm* we find is by Josselyn in 1675 (An Acct. of two Voy. to N. England, p. 117), but the insects were true canker-worms; and later the name was applied to the true army-worm and doubtless other injurious insects.



25.— *The palmer-worm under its scanty silken net. Natural size in lower corner.*

26.— *Palmer-worm moths, showing some of their variations.* ***Enlarged; for natural size see figure 25.***

general color is olivaceous or brownish-green, lighter on the venter, and usually with a light brown head. Two lateral and two dorsal whitish stripes give the dorsum the appearance of being transversed by two broad dark stripes and a similar, narrower mesal stripe of the general body color; this is well shown in the enlarged picture of the palmer-worm in figure 25. There is considerable variation in the general color of the body and head, as is shown in figure 27.*



27.— *Palmer-worms, showing their variations.*

* The following detailed description of the caterpillars when alive is transcribed from our notes: Length, half an inch. The general color of venter, prolegs and true legs varies from a very light apple-green to a light olive-green, or often from a very light yellowish-brown to a flesh color. The dorsum is considerably darker, varying from a light to a dark olive-green, and some have a distinct brownish shade. Each side of the mesal line on the dorsum extends a narrow, somewhat broken, whitish stripe, and the darker dorsum is separated from the venter by a similar whitish stripe; this gives to the dorsum the appearance of being transversed by two broad, dark stripes, each of which is bordered on its sides by a narrow whitish stripe (see figures 25 and 27); on some specimens where the dorsum is but little darker than the venter or where the whole larva is darker, these whitish stripes are not nearly so distinct (see upper and lower caterpillars in figure 27). The head is usually of a light yellowish-brown color. On the lighter colored specimens (see upper larva in figure 27) the thoracic shield is

The adult insect or moth.— The palmer-worm moth is a minute gray or brownish gray insect, measuring across its expanded wings only a little more than half an inch (14 to 17 mm.). The front wings are more or less sprinkled with black scales, and usually four small black spots, arranged obliquely, are to be distinguished near the middle of each front wing; near the fringed edge there are also six or seven small black dots, and sometimes a dusky band crosses the wing between the central black spots and the outer fringe. The hind wings are heavily fringed, and are of a dusky color with a glossy azure-blue reflection. The antennæ have a ringed appearance, the joints being alternately dark and light.

The moth is well shown, natural size, in the lower left-hand corner of the enlarged pictures in figures 23 and 24; figure 24 is a reproduction from photos taken from life of the moth at rest, with front portion of the body slightly raised, on an apple leaf. The moth is quite variable in general color and markings, as is well shown in figures 23 and 26.*

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concolorous with the head, except a trace of a blackish, caudal border; usually, however, this shield is marked with a black u-shaped spot on each half, the width of the arms of the u varying considerably and merging into the following variety of this caterpillar.

General body color on dorsum is a dark olive-green; the head is of a very dark brown, almost black, color, and the thoracic shield is nearly covered by the black, u-shaped spots (see lower larva in figure 27). This variety is doubless Fitch's Comrade Palmer-worm (*Y. contubernalellus*).

The larvæ are sparsely hairy, the hairs arising from black spots. These black piliferous spots are much more distinct on some specimens, usually being much less distinct on the lighter colored larvæ; but on the thoracic segments they are always very distinct. The abdomen bears five pairs of pro-legs, the caudad pair being much larger and projecting caudad as shown in figure 25, when the larva is at rest.

* Fitch described seven different varieties of the moth (2d Rept., 229, 233), and described the variety shown on the right in figure 26 as a distinct species, the comrade palmer-worm (*contubernalellus*). Largely on account of this variation of the moths, the insect has been described as a new species under at least six different names (see the synonomy on page 111). Most of the differences are due to the variation from an ash-gray to a tawny-yellow color of the front wings, the absence of or unusual distinctness of one or more of the black dots near the center of the wing, or the absence of the dusky band toward the outer fringe.

The most remarkable variation, however, is shown on the right in figure 26, where the costal half of the wing is of a light tawny-yellow color and the other

ITS NAME.

Under the heading "What are Palmer-worms?" we have told how the popular name of *palmer-worm* came to be applied to this insect. In 1791, apparently the first time the caterpillars had attracted attention by their injuries, they were commonly called palmer-worms, and it is a notable fact how so general a term has ever since been retained for this insect. It is an unfortunate use of the name, however, for the caterpillars are not *wanderers* or *palmers;* it would be an apt name for some of the "yellow or woolly-bear caterpillars," thus continuing the 16th and 17th century application of it.

Another much more suggestive popular name for this pest was applied to it by some Massachusetts agriculturists during its next outbreak in 1853; they called it the *canker-worm, Jr.* The caterpillars are smaller than, and they somewhat resemble, canker-worms; and the work of the two on the foliage is very similar, hence "junior canker-worm" or "canker-worm jr." is a more suggestive name but rather clumsier than "palmer-worm."

The insect has been described under several different scientific names, and we are not yet sure if it was first described as *ligulella* in Europe in 1818 from specimens obtained in Georgia; at present, the name—*pometellus*—which Harris gave it in 1853 in this

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half is dark brown. This variety has received three distinct names (see synonomy on page 111) and is possibly the insect described much earlier by Hübner. Fitch supposed that this moth was the adult form of the black-headed and black-necked palmer-worms which he found associated with the typical palmer-worms. But he did not breed the moth from such larvæ, and as apparently no one had done so, we separated out several of these black-headed larvæ and kept them in a separate cage. We reared two moths from these larvæ, one a typical *pometellus* and the other Fitch's *contubernalellus;* this is an indication, but should be verified with more specimens, that the latter insect is simply a variety of the typical form; and the fact that we reared several moths of the *contubernalellus* form in our cages containing apparently typical palmer-worms is a further indication. None of the moths we have reared from palmer-worms show gradations between these two forms, but Walsingham records such graded specimens. We have thought it best to give *contubernalellus* varietal rank in our synonomy on page 111, but if it can be shown that Hübner described the same insect, as *ligulella*, his name must be applied to the insect and Harris' name and all the others fall as synonyms.

country is retained for the insect.* Its whole name — *Ypsolophus pometellus* — literally translated means the "tufted-crowned orchard moth."

ITS DISTRIBUTION AND WHERE INJURIOUS.

The insect is known to occur only in the United States, where it apparently has a wide distribution. It is, at times, very common in New Jersey, New York, and throughout the New England States; and it has been recorded from Ohio (common), Kentucky, Missouri, Mississippi, Texas, Virginia and Georgia (?).

Apparently only in New York and the New England States have the caterpillars done noticeable injury.

ITS "UPS" AND "DOWNS" AND EXTENT OF ITS RAVAGES.

We recall no other injurious insect which has suddenly appeared over so large an area, then doing much injury for only a year or two, and as suddenly ceasing to attract attention, and finally remaining in obscurity for half a century at a time. As stated in the introductory paragraph, many of our injurious insects have these "ups" and "downs," or periods of increase and decrease in numbers and extent of their ravages. Usually, however, the injurious period extends over several years and not many years elapse before there is a recurrence of the injuries. But the palmer-worm presents a remarkable instance of an insect having thus far done noticeable injury only about one year in every fifty!

Historical notes on previous outbreaks.— Apparently the first time this insect ever attracted attention was in 1791.† That

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* See foot-note on page 95 and the synonomy on page 111 for a technical discussion of its scientific name.

† In his "Travels into North America" (Trans. by Forster, Vol. II., p. 7) Peter Kalm describes in 1748 the serious ravages of caterpillars in the forests. Fitch quotes Kalm's account and states that the insects were "most probably" palmer-worms. After critically studying Kalm's description, however, we believe that it is more than probable that the caterpillars were not palmer-worms, but were either tent-caterpillars or some other similar large insect.

Fitch's next statement that "if our western prairies were ever covered with wood it is most probable by this insect that they were first made naked" is too great a stretch of the imagination, and it seems quite unlike Dr. Fitch's usual conservative deductions or theories.

year the caterpillars appeared in excessive numbers and ravaged apple and forest trees in Cumberland county, Maine, and in other parts of New England. Doubtless accounts of this outbreak of the insect appeared in some of the newspapers or other publications of that time, but the first published account which we have been able to find is in the valuable and interesting book known as Deane's New England Farmer or Georgical Dictionary, the second edition published in 1797 (the 1st edition was issued the year preceding the outbreak). Deane briefly describes the caterpillars and their work, and states that the following year there were none to be seen.

After thus practically disappearing as suddenly as it came, the insect remained in obscurity for the remarkably long period of sixty-two years, or until 1853. As Burnett states, in June, 1853, the caterpillars suddenly appeared in great numbers in "the central and eastern portion of New York State; the adjacent portions of Vermont; Salisbury and New Haven, Conn.; and the valley of the Connecticut and Housatonic Rivers; New Boston and Keene, N. H.; Providence, R. I.; and the northeastern section of Massachusetts. I notice these places or localities particularly, since the devastations were there very marked; and in some of them the worms not only ate the leaves of the trees, but afterwards devoured the young fruit. In some places they have made such a complete sweep that the orchards look as though a fearful blight had passed over them. I have made considerable search to learn if they have been particularly numerous in their original and former locality, Cumberland county, Me., but I have been able to obtain no information from that quarter." So serious and widespread was this outbreak of the insect in 1853 that it was noticed in the newspapers everywhere from Maine to Connecticut, and Harris and Fitch then contributed about all the economic literature we have on the insect.

Fitch states that in New York "the trees everywhere assumed a brown, withered appearance, looking as though they had been

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It is not improbable that the palmer-worm may have appeared in injurious numbers in New England previous to 1791. But there is such confusion in the use of popular names of insects and so little descriptive material in the early annals, that we have been unable to glean any definite evidence of an earlier outbreak.

scorched by fire. Apple-trees and oaks seemed to suffer most, but all other trees and shrubs were more or less infested with these worms at this time. On jarring or shaking a tree, hundreds would instantly let themselves down from among the leaves, by fine threads like cobwebs, some dropping to the ground, others remaining suspended in the air. Persons at work at this time upon potatoes or other field crops growing in orchards would have numbers of them crawling everywhere over their clothes. * * * The crop of fruit for the year was everywhere destroyed."

Writing in 1856, Fitch states that the year following the excessive ravages of the palmer-worms, "it was universally expected, in June, that these worms would again appear, but the month passed away and no traces of them were anywhere to be seen. They could readily be found, however, on searching upon the leaves of the apple-trees, but were no more common than several other kinds of worms in the same situation. Last year, 1855, they were quite rare, a very few specimens only having presented themselves to my notice. The present year they have been much more abundant, and in gardens in the city of Albany I observed a number of fruit trees the leaves of which had been badly eaten by them."

Thus, soon after its sudden appearance and excessive ravages in 1853, the insect ceased to attract attention, and did not again pose as an injurious insect for fifty-seven years, or until 1900.

We can not satisfactorily explain these remarkable "ups" and "downs" in the life-history of the palmer-worm during the past 100 years, during which period it has been noticeably injurious only three times. It has natural enemies which doubtless are a factor in reducing the numbers of the insect below the danger limit, but probably climatic conditions are more potent factors. In this connection it is worthy of note that in Deane's account of the outbreak in 1791, he states that "the spring which preceded their appearance had been remarkably dry, both in April and May." And Fitch states that the weather in 1853 had been remarkably dry and hot for some time previous to the advent of the insect. The spring months of 1900 were also much drier and hotter than usual. Evidently, then, extreme dry and hot weather in the spring are very favorable for the development of the insect.

Extent of ravages in 1900.— Suddenly, during the second week in June last, many fruit-growers in New York discovered that what was apparently a new insect pest was seriously injuring the foliage and young fruit on their trees. We received daily several letters, accompanied by specimens of the caterpillars, which proved to be palmer-worms. In some sections our correspondents reported that much damage was being done in apple orchards. Reports of damage by the pest came to us from central and western New York only, and included the following nine counties: Chautauqua, Niagara, Orleans, Genesee, Monroe, Wayne, Cayuga, Tompkins and Oneida. In many orchards the caterpillars ruined thousands of the young apples, and had not the crop been so unusually large the loss from the palmer-worm's ravages would have been much more noticeable and serious.

So far as we know, the insect did not attract attention in 1900 in its old haunts anywhere in New England, but confined its ravages to central and western New York. Perhaps this was simply a prelude to a more general outbreak next year, but we are hopeful that it may have again entered upon another half-century period of obscurity, and thus will not again trouble this generation of fruit-growers.

FOOD-PLANTS.

In describing the first outbreak of this insect in 1791, Deane states that "I have seen them only on apple trees and oak trees, in any great abundance." In 1853 Harris found the caterpillars on his plum and cherry trees, and apple orchards in New York and New England were their favorite feeding grounds; Fitch states that "apple trees and oaks seemed to suffer most, but all other trees and shrubs were more or less infested with these worms at this time." In 1872 what is now considered the palmer-worm moth was reared in Kentucky from caterpillars found feeding in the large globular galls formed on oak leaves and known as "spongy oak-apples."*

* This moth was aptly named *quercipomonella* — the oak-apple moth. In Packard's volume on Forest Insects, p. 202, Riley gives under this name a detailed description of the larva and pupa of an insect found "folding up the leaves of the black oak in little tubes" in 1868. These descriptions of Riley, and that of Chambers of the larva he found in "oak-apples," agree fairly well with our palmer-worms, which are quite variable.

We saw the caterpillars only on apple trees in 1900, and had complaints of their ravages from apple-growers only.

Thus the favorite food of the insect seems to be the foliage of apple and oak, and on the former tree the fruit is also included in the caterpillar menu, while on the oak, curiously enough, the "oak-apple" galls are also eaten.

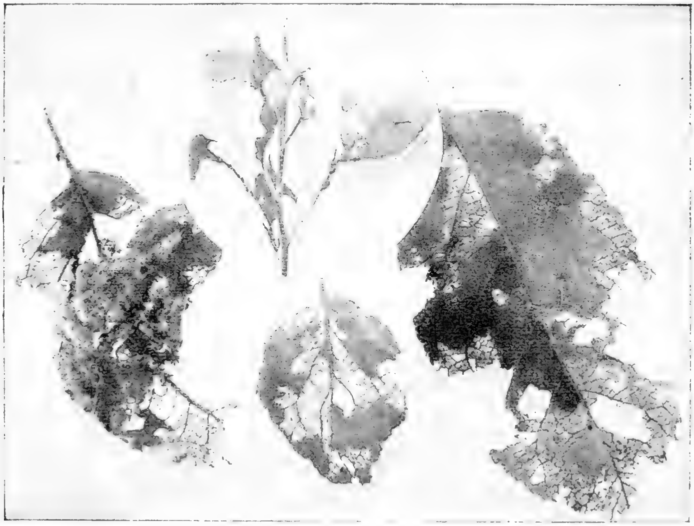
THE STORY OF THE PALMER-WORM'S LIFE.

Nothing has been recorded of the life and habits of the palmer-worm, except for the months of June and July. During these two months the caterpillars do most of their feeding and soon transform through the pupa stage into the little moths; these three stages in the life of the insect were described in detail by Harris and Fitch in 1853, but there is no hint of how the insect spends the remaining ten months of its yearly life-cycle. We have been able to follow it from July until it goes into hibernation, and are thus enabled to give a reasonable guess as to how it lives during the rest of the year.

Its appearance and work in June.— The records of both previous outbreaks — in 1791 and in 1853 — of this insect state that the caterpillars first attracted attention from the 10th to the 15th of June. Our New York fruit-growers also first noticed the insect about this time in June, 1900. The caterpillars or palmer-worms were then mostly over half-grown, and their work was most conspicuous.

They skeletonized the leaves (see figure 28), usually leaving the veinlets, but sometimes eating irregular holes through the leaf, and often devouring nearly all of the youngest and tenderest leaves at the tip of a branch, as shown on the branch near the center of the upper part of figure 28. Their work on the leaves is very much like that of canker-worms. Sometimes two or three leaves are fastened together with silken threads spun by the palmer-worms thus forming a sort of nest within which they feed. Often they feed openly on the surfaces of the leaves, but many of them draw over with silken threads one edge of the leaf at the side or near the tip, as is well shown in lower corner of figure 25, thus forming a partial tube or roll within which they feed underneath their silken bridges, as shown in the same figure.

In some localities the foliage on many apple trees was badly damaged by the palmer-worms, but many reported much damage to the young fruits also. This peculiar habit of eating the fruits is not mentioned in the accounts of the outbreak of the insect in 1791, but in 1853 much fruit was ruined by the caterpillars. In 1900, while they destroyed many thousands of young apples in some orchards, the trees were usually overloaded, so the loss was not so noticeable. Their manner of working on the fruit is graphically shown in figure 29, where two of the caterpillars can be seen at their nefarious



28.— *Apple leaves skeletonized by palmer-worms, natural size; also young leaves at tip of branch badly eaten, near center at top of figure, reduced.*

work. Irregular holes, sometimes extending into the core, and of varying sizes and depths are eaten into the sides of the fruits; sometimes a long, irregular, shallow furrow will be eaten nearly around the fruit. Usually the caterpillar spins more or less silk across the cavity, as is shown in figure 29. Where the hole extends to the core, the fruit often withers and drops off, while many slightly injured fruits remain and partly overgrow the injury, but never make first-class fruits. This fruit-eating habit of the caterpillar makes the insect a much more destructive and serious pest than it

would usually be if it confined its work to the foliage, like the canker-worms.

The caterpillars are exceedingly lively little creatures. They do not loop or measure along like the canker-worms, but when touched they move rapidly forward or backward with a wriggling motion. If the branch on which they are at work is jarred, the caterpillars quickly drop, but remain attached to a silken thread which they spin as they go. Sometimes they will thus drop to the ground, but usually they remain suspended by threads two or three feet long, finally climbing back up the thread. Some correspondents reported that when they jarred a large branch on an infested apple tree, 25 or

29. — *Young apples eaten into by palmer-worms, natural size. Note the caterpillars in the first and third apples from the right.*

more of the caterpillars would suddenly appear dangling in the air, as canker-worms do.

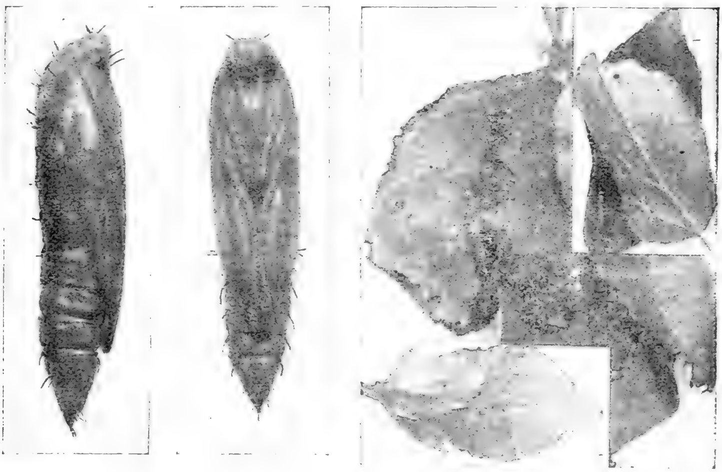
While the palmer-worms thus closely resemble the canker-worms in their manner of working on the foliage and in their habit of spinning down when jarred, they are readily distinguished by their wriggling instead of a looping motion, and when full-grown they are only about half as large as canker-worms.

Its destructive period.— All of the injury caused by this insect is done by the caterpillars as they feed upon the foliage and young fruits, and their work is practically confined to the month of June; doubtless many of the caterpillars hatch out and do a little feeding

in May. About the middle of June, they are apparently the most numerous and their ravages the most conspicuous.

During the rest of the year the insect would rarely attract the attention of the sharpest-eyed horticulturist.

The pupa stage. — By the last week in June, most of the caterpillars will seem to have disappeared, but careful search on the injured leaves will reveal small brown, lifeless-looking objects attached openly to the leaf by a few silken threads at their posterior end, or they may be hidden in the slight nest or home made of



30.— *Pupæ of the palmer-worm; lateral and ventral views on the left, enlarged Two pupæ, natural size, attached to leaves, on the right; with pupal home between two leaves in lower part of right-hand portion of figure.*

two or three leaves by the caterpillar. These mummy-like brown objects, shown much enlarged at the left in figure 30, are the pupæ into which the caterpillars have transformed; at the right in the same figure, are shown two of these pupæ, natural size, as they were formed on the leaves, and the fastening of two leaves together to form a pupal home is also shown.* In our cages, many pupæ

* The pupæ measure 7 to 8 mm. in length and are of a light brown color until the moth is nearly ready to emerge, when they become dark brown. Their general characteristics are well shown in figure 30. On the dorsum of the first four abdominal segments there are two slight, shiny, blunt elevations, near the caudal border of the first segment, and near the cephalic border of the others.

were formed naked on the surface of the soil and others in a slight silken web just beneath the surface of the soil. Probably most of the pupæ would be found on the leaves in the orchard, but should a rain-storm drive or knock the full-grown caterpillars from the trees, as it easily might do, then doubtless many would pupate on the ground under leaves or other protection, or possibly on the rough bark of a tree.

The insect remains enshrouded for about ten days in this pupal skin, where most of its elaboration or transformation from a caterpillar to the adult or moth takes place.

Emergence and habits of the moths. — Some of the moths emerge from the pupæ during the last week in June, but a majority of them appear during the first ten days in July. Apparently the moths are not active during the day, unless disturbed, when they fly but a short distance and alight. They rest on the leaves or in cracks or crannies in the characteristic position shown in figure 24, standing with the forward portion of the body raised slightly.

Where and how does the insect live between July and the next June ? — All writers have been silent on this important question of how and where the palmer-worm passes nearly eleven months of its yearly life-cycle; we find no hint or guess in the literature on this point. Nearly all of the moths we reared emerged from the 5th to the 10th of July. And confidently expecting that they would soon lay eggs from which would hatch another brood of caterpillars, we placed many moths in cages containing fresh leafy branches of apple and a piece of bark. We kept the cages supplied with fresh branches, but at the end of about a week, we could discover no eggs and some of the moths had died. We then moistened some lumps of loaf sugar, and put them on the soil in the cages. The moths began feeding on the sugar in a few minutes, and some could be seen feeding at almost any time afterward. No moths died as long as we kept them supplied with the sugar, and, although we kept fresh branches in the cages and carefully examined the old branches when removed, we failed to find any eggs. This was continued until we were much surprised to see those tiny moths live in our small cages from July 5th until nearly November 1st, almost

four months, when we broke up the cage, as it was quite evident that these July moths would hibernate!

And yet we were not surprised when we received a letter from a correspondent at Albion, N. Y., dated August 25th, and stating that the second brood of palmer-worms were then about half grown and and many had just hatched. We immediately went to Albion and found on the apple trees many little caterpillars very similar in appearance and habits to palmer-worms. We doubted their identity at once, and upon opening the box containing our specimens on our return to the insectary, we found that the supposed palmer-worms had spun the characteristic, white, ribbed cocoons of the apple bucculatrix caterpillar (*Bucculatrix pomofoliella*). We wrote to other infested localities, but no one had seen anything of a second brood of palmer-worms. We feel sure that there is but one brood of the caterpillars during a year.

It seemed incredible that such tiny moths could live through most of the summer and all of autumn and then hibernate until spring. Stainton states that there is but one yearly brood of the caterpillars of the European species of this genus of insects; in some species the caterpillars work in September and hibernate in that stage, and of a species whose caterpillar works in June on clover, he says nothing about how it hibernates. In reply to our query if he had any data on this point, Professor C. H. Fernald wrote us: "There are many of the Tineids that hibernate in the imago state. I have collected several species of *Ypsolophus* under such circumstances as to lead me to believe that they hibernate in that stage."

We are thus forced to conclude that there is but one brood of palmer-worms in a year, and that the moths issuing early in July go into hibernation without having laid their eggs.

The eggs.— Apparently no one has yet seen the egg laid by a palmer-worm-moth. We confidently expected to have induced the moths to lay eggs in our cages, but as we have just shown above, it was working against Nature. Evidently the eggs are not laid until spring, and then doubtless somewhere on the tree where the caterpillars are to feed. We will hazard a guess that the eggs are laid in May on the bark of the branches or on the opening leaves, and that the caterpillars hatch from the 15th to the end of May.

There is thus one stage — the egg — in the palmer-worm's life that we know nothing definite about. But our observations have filled the great gap from July till the next spring, and it now remains for someone to discover the egg, which we believe is laid and hatched in May, and thus complete the life-story of the insect.

NATURAL ENEMIES.

That the palmer-worm has appeared in injurious numbers only three times in over a century is largely due, we believe, to the efficient work of its enemies in Nature. Among these checks to its increase, certain climatic conditions doubtless rank first. Apparently excessively dry and hot weather in April and May is much more favorable for its development, and both Fitch and Harris agree that palmer-worms of all sizes suddenly disappeared from the trees in 1853 with showers of rain in June. The rain probably jars or knocks the caterpillars from the foliage onto the ground, and it may then kill them, or more likely they do not find their way back to the foliage. Thus the moist conditions which usually prevail in the spring and early summer apparently serve as Nature's most effective check to the development of this insect in injurious numbers.

The palmer-worm also falls a prey to enemies among its own kind. Fitch has graphically told the story thus: "Numbers of these worms are every year destroyed by a small footless grub or maggot, which lives in the palmer-worm until it has attained its growth, when it perforates a hole through the side of the worm, and crawling out spins a small, white, oval cocoon for itself, commonly attaching this cocoon very slightly to the surface of the leaf. The worm from which this parasite has crawled remains upon the leaf beside it, its feet seemingly paralyzed, so that it is unable to move from the spot. It turns its head at times from one side to the other, but eats no more and soon perishes." Harris states that more than half of the caterpillars he tried to rear in 1853 were killed by this little parasite. Several of the caterpillars in our cages also succumbed in a similar manner in June last; it was doubtless the work of the same parasite that killed so many of the caterpillars in 1853.

From the little cocoon spun beside their dying host, we reared a

few minute hymenopterous or four-winged flies; and we were surprised to find, upon submitting them to an expert, Mr. Ashmead, that they were practically new to science. He had received one specimen of the parasite from Illinois and had named it in his manuscript as *Apanteles perplexus*. His manuscript description will doubtless soon be published.

This little parasite seems to be a valuable friend of man so far as the palmer-worm is a menace to fruit-growing.

REMEDIAL MEASURES.

Historical.— In Deane's quaint account of the outbreak of the palmer-worm in 1791, he states: "I made smokes under the fruit-trees without any apparent effect. As they let themselves down by threads, they may be thinned by shaking the trees, and striking off the threads." Fitch states that in 1853 some practiced the latter method, repeating the operation day after day, but with little benefit. He suggested that an old tin pan, smeared with tar or other sticky substance, be fastened to the pole and the caterpillars caught on this as they hung suspended. These primitive and only partially effective methods are too laborious to receive further attention.

The fact that showers of rain were apparently effectual in ridding the trees of the caterpillars in 1853, led Fitch to suggest that the infested trees be showered with water. And he reports that an Albany fruit-grower preserved his trees from the ravages of the pest by drenching them with a whale oil soap solution. Doubtless a thorough spraying with the soap solution would kill or knock off most of the palmer-worms.

Fortunately for the fruit-grower, the palmer-worm presents a very vulnerable point of attack, and we can see no reason why it should not readily succumb to our modern methods of spraying for fruit pests.

The caterpillars bite off and swallow portions of the leaves and of the young fruits. Sometimes they are partially protected in a slight tube or roll of a leaf, or between two leaves, but often where numerous they feed openly on the upper surface of the leaves. Hence it is only necessary to thoroughly spray the feeding grounds of the caterpillars with Paris green to include a dose of poison in

their menu for that or some succeeding day. The two regular sprayings necessary for the codling-moth, one just after the blossoms fall and the other a week or ten days later, with Paris green, or some similar poison, and the Bordeaux mixture, if they are thoroughly done, should kill enough of the palmer-worms to prevent their doing noticeable damage for the season.

Some reported to us in June last that they failed to check the ravages of the insect with a poison spray, but many others reported very effectual work with such a spray. The failures must have resulted from lack of thoroughness, impure chemicals, or some similar cause. We believe that one or two thorough applications of a poison spray about June 1st will surely control this pest for the season.

We hope that the palmer-worms will continue to have such remarkable "ups" and "downs" in their life as they have had during the past hundred years so that they will not again trouble our fruit-growers for another half century; but as one never can foretell Nature's secrets, horticulturists may soon have occasion to wish that they had, like Hiawatha:

"Learned their names and all their secrets,
How they built their nests in summer,
Where they hid themselves in winter,
Talked with them when'er he met them."

MARK VERNON SLINGERLAND.

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1853. Harris, T. W. *Mass. Ploughman*, July 9, July 30; *Boston Cultivator*, July 16; *New England Farmer*, July 16, August (p. 370); *Middlesex Farmer*, July; *Journal of Agriculture*, July. Brief accounts of characteristics, habits and ravages.

Harris, T. W. *Cambridge Chronicle* for July 19th. Good brief account of habits, with description of larva, pupa and moth. Gave the insect its scientific name, *Rhinosia pometella;* same account in Trans. N. Y. State Agr. Soc., XIII., p. 190–192 (1854).

Fitch, A. *Salem Press* for July 12th. Good detailed account of the larvæ and their habits. Supposed moth described as *Argyrolepia pomariana.*

Fitch, A. Journal N. Y. State Agr. Soc., IV., 36. Preceding account republished, with postscript correcting error in naming wrong moth and augmenting Harris' description, with criticism on name; placed moth in genus *Chaetochilus*, and described as a distinct species *C. contubernalellus*, now considered as a variety only. Same article in Trans. N. Y. State Agr. Soc., XIII, 178–187 (1854).

Harris, T. W. Jour. N. Y. State Agr. Soc., IV., 39. Brief letter to Johnson giving portions of country ravaged and pointing out Fitch's error in naming wrong moth. Same article in Trans. N. Y. State Agr. Soc., XIII., 189 (1854).

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one in the literature, and no other illustrations of the insect appeared until 1900.

Fitch, A. Third Rept. on Insects of N. Y., 344, 384. Brief account.

1863. Clemens, B. Proc. Ent. Soc. Phila., II., 123. Moth described as *pauciguttellus.*

1864. Clemens, B. Proc. Ent. Soc. Phila., II., 429. Moth described as *flavivittellus* from Va. (equals Fitch's var. *contubernalellus*).

1872. Chambers, V. T. Can. Ent., IV., 222. Moth described as *reedella*, and as *quercipomonella;* larvæ of latter described, from "oak apple" gall.

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1878. Chambers, V. T. Index to Tineina (Bull. U. S. Geol. Surv. IV., 166–167). Synonomy and references.

1881. Packard, A. S. Half Hours with Insects, 183–186. Good account compiled from Fitch.

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1883. Saunders, W. Insects Injurious to Fruits, 102–105. Good account compiled from Fitch. Same in 1892 edition.

1890. Riley, C. V. Packard's Forest Insects, 202. Larva and pupa described as *quercipomonella.* Folds leaves of black oak. Descriptions apply fairly well to some of our specimens of *pometellus.*

Smith, J. B. Cat. of Insects of N. J., 357. Common on apple, pear, plum, etc.

1891. Riley, C. V. Smith's List. of Lep., Tineina, 103. Lists *contubernalellus* as distinct species, and *flavivitellus* as a variety of *pometellus.*

1894. Bruner, L. Nebr. State Hort. Rept. for 1894, 159. Listed as an enemy of apple. Also included in similar list in Rept. of Hort. Soc. for 1899, p. 126.

1899. Lugger, O. Fourth Rept. of Ent., 252–53. Brief account compiled from Fitch. Calls var. *contubernalellus* the "Comrade Plum Worm."

1900. Smith, J. B. Insects of N. J., 475. Common; larva on apple, pear and plum.

Lowe, V. H. *Rural New Yorker*, July 14th, p. 477. Good detailed account of outbreak in N. Y., with five photo pictures of larvæ, pupæ, and the insect's work. We fail to verify reference of an account by Glover.

SYNONOMY.

? *Dichomeris ligulella.* 1818. Hübner, Zuträge, p. 70, figs. 143 and 144. Fernald writes us that he believes Fitch's *contubernalellus* to be this Hübnerian insect. "I have had Hübner's figures in my mind for years and this is the only

North American insect I have seen that at all resembles it." Walsingham also indicates a similar belief (Trans. Am. Ent. Soc , X., 187).

Rhinosia pometella. 1853. Harris, *Cambridge Chronicle* for July 19th. Original description of moth.

Chaetochilus pometellus. 1853. Fitch, Jour. N. Y. State Agr. Soc., IV., 36.

Chaetochilus contubernalellus. 1853. Fitch, Jour. N. Y. State Agr. Soc., IV., 36.

Ypsolophus pauciguttellus. 1863. Clemens, Proc. Ent. Soc. Phila., II., 123.

Ypsolophus flavivittellus. 1864. Clemens, Proc. Ent. Soc. Phila., II., 429. Equals Fitch's var. *contubernalellus*. Zeller (Verb. Ges. Wien, 1873, p. 283) made this a var. of *pauciguttellus*, and suggested that the latter must give way to Harris' *pometellus*.

Ypsolophus reedella. 1872. Chambers, Can. Ent., IV., 222. Says it is possibly a var. of *pometellus*. Misspelled *ruderella* in Bull. U. S. Geol. Surv., IV., 166.

Ypsolophus quercipomonella. 1872. Chambers, Can. Ent., IV., 222. Says it resembles Fitch's *contubernalellus*.

Ypsolophus pometellus Harris.*
pauciguttellus Clemens.
reedella Chambers.
Var. *contubernalellus* Fitch = ? *ligulella* Hübner.
flavivittellus Clemens.
quercipomonella Chambers.

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* *Argyrolepia pomoriana* and *sylvaticana* Fitch (*Salem Press*, July 12, 1853) are not synonyms of *Ypsolophus pometellus* Harris, as indicated by Felt in his Index to Lintner's Writings, p. 600; for Fitch stated soon afterward (Jour. N. Y. State Agr. Soc., IV., 36) that the insects to which he applied these names were both very different moths from the palmer-worm moth. Were these names synonymous they would have priority of a week over Harris' name.

THE FOLLOWING BULLETINS ARE AVAILABLE FOR DISTRIBUTION TO THOSE WHO MAY DESIRE THEM.

40 Removing Tassels from Corn, 9 pp.
71 Apricot Growing in Western New York.
72 The Cultivation of Orchards, 22 pp.
74 Impressions of the Peach Industry in N. Y., 28 pp.
76 Some Grape Troubles in Western N. Y.
79 Varieties of Strawberry Leaf Blight.
80 The Quince in Western N. Y., 27 pp.
87 Dwarf Lima Beans, 24 pp.
93 Cigar-Case-Bearer, 20 pp.
97 Entomogenous Fungi, 42 pp.
101 Spraying of Trees and the Canker Worm.
102 General Observations in Care of Fruit Trees, 26 pp.
103 Soil Depletion in Respect to Care of Fruit Trees, 21 pp.
109 Geological History of the Chautauqua Grape Belt, 36 pp.
110 Extension Work in Horticulture, 42 pp.
114 Spraying Calendar.
116 Dwarf Apples, 31 pp.
117 Fruit Brevities, 50 pp.
119 Texture of the Soil, 8 pp.
120 Moisture of the Soil and Its Conservation, 24 pp.
121 Suggestions for Planting Shrubbery.
122 Second Report upon Extension Work in Horticulture, 36 pp.
123 Green Fruit Worms, 17 pp.
124 The Pistol-Case-Bearer in Western New York, 18 pp.
126 The Currant-Stem Girdler and the Raspberry-Cane Maggot, 22 pp.
129 How to Conduct Field Experiments with Fertilizers, 11 pp.
130 Potato Culture, 15 pp.
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134 Strawberries under Glass, 10 pp.
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136 Chrysanthemums, 24 pp.
137 Agricultural Extension Work, sketch of its Origin and Progress, 11 pp
38 Studies and Illustrations of Mushrooms; I, 32 pp.
139 Third Report upon Japanese Plums.
140 Second Report on Potato Culture, 24 pp.
141 Powdered Soap as a Cause of Death Among Swill-Fed Hogs.
142 The Codling-Moth.
143 Suger Beet Investigations, 88 pp.
144 Suggestions on Spraying and on the San Josè Scale.
145 Some Important Pear Diseases.
146 Fourth Report of Progress on Extension Work, 26 pp.
147 Fourth Report upon Chrysanthemums.
148 Quince Curculio, 26 pp.
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150 Tuberculosis in Cattle and Its Control.
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157 Grape-vine Flee-beetle.
158 Source of Gas and Taint Producing Bacteria in Cheese Curd.
159 An Effort to Help the Farmer.
160 Hints on Rural School Grounds.
161 Annual Flowers.
162 The Period of Gestation in Cows.
163 Three Important Fungous Diseases of the Sugar Beet.
164 Peach Leaf-Curl.
165 Ropiness in Milk and Cream.
166 Sugar Beet Investigations for 1898.
167 The Construction of the Stave Silo.
168 Studies and Illustrations of Mushrooms; II.
169 Studies in Milk Secretion.
170 Tent Caterpillars.
171 Gravity of Dilution Separators.
172 The Cherry Fruit-Fly: A New Cherry Pest.
173 The Relation of Food to Milk-Fat.
174 The Problem of Impoverished Lands.
175 Fourth Report on Japanese Plums.
176 The Peach-Tree Borer.
177 Spraying Notes.
178 The Invasion of the Udder by Bacteria.
179 Field Experiments with Fertilizers.
180 The Prevention of Peach-Leaf Curl.
181 Pollination in Orchards.
182 Sugar Beet Investigations for 1899.

Bulletins Issued Since the Close of the Fiscal Year, June 30, 1900.

183 Sugar Beet Pulp as Food for Cows.

184 The Grape Root-Worm; New Grape Pest in New York.

185 The Common European Praying Mantis; A New Beneficial Insect in America.

186 The Sterile Fungus Rhizoctonia.

187 The Palmer-Worm.

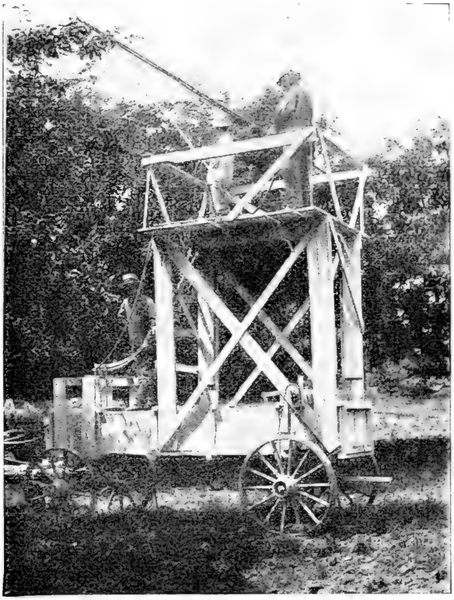
Bulletin 188. **March, 1901.**

Cornell University Agricultural Experiment Station,

ITHACA, N. Y.

HORTICULTURAL DIVISION.

SPRAY CALENDAR.



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SPRAYING.

In the preparation of this calendar the most important points regarding sprays have been selected and arranged in such manner that the grower can see at a glance what to apply and when to make the applications. The more important insects and fungous enemies are also mentioned, so that a fairly clear understanding of the work can be obtained by examining the table below. When making the applications advised, other enemies than those mentioned are also kept under control, for only the most serious ones can be named in so brief an outline. The directions have been carefully compiled from the latest results obtained by leading investigators.

In this calendar it will be seen that some applications are in parentheses: these are the ones that are *least important.* The number of applications given in each case has particular reference to localities in which fungous and insect enemies are most abundant. If the crops are not troubled when certain applications are advised, it may be unnecessary to make applications at these times. It should be remembered that in all cases success is dependent upon the exercise of proper judgment in making applications. Know the enemy to be destroyed; know the remedies that are most effective; and apply them at the proper season. *Be prompt, thorough and persistent.* Knowledge and good judgment are more necessary to success than any definite rules. Spraying is an insurance.

Spraying is no longer an experiment. Is it an accepted practice, as tillage, pruning and fertilizing are. It may not be necessary to spray every year, but the farmer should be prepared to spray every year. In case of doubt, *spray.*

See that pumps and rigs are in working order before plowing time comes. Order your materials. Pattern after the bugs: be ready.

There is no one best pump or nozzle. There are best devices for particular kinds of work, depending on the size of plants to be sprayed, the kind of spray to be used, the extent of the operations. Get a good pump, one that works easily and smoothly and is strong enough to make a fine spray when two lines of hose and four nozzles are used, if it is designed for field work; it is economy in the end. Look over the agricultural papers for advertisements of spraying outfits and write for circulars.

The advice given in this Bulletin is intended to be suggestive merely. In so brief a space it is impossible to go into details. The person who wants fuller information must consult bulletins of this and other stations on the special subjects.

Apple.

Scab. (1. Copper sulfate solution before buds break); 2. Bordeaux mixture when leaf buds are open, but before flower buds expand; 3, repeat 2 as soon as blossoms have fallen; 4. Bordeaux mixture 10 to 14 days after the third; (5, 6, repeat 4 at intervals of about two weeks). See Bulletin 84. **Canker.** Cut out badly diseased parts; when spraying for scab, spray trunk and branches. **Canker-worm.** 1. When first caterpillars appear apply Paris green very thoroughly; 2, repeat 1 after 4 to 10 days; (3, 4, repeat every 10 days if necessary). See Bulletin 101. **Bud-moth.** 1. As soon as leaf tips appear in buds, Paris green; 2, repeat 1 before the blossom buds open; (3, repeat 2 when blossoms have fallen). See Bulletin 107. **Codlin-moth.** 1. Paris green immediately after blossoms have fallen; 2. Repeat 1, 7 to 10 days later. Use burlap bands on trunks, killing all insects under them every 10 days from July 1st to August 15th, and once later before winter. Paris green may be added to the Bordeaux mixture and the two applied together with excellent effect. See Bulletin 142. **Case-bearer.** As for *Bud-moth*. See Bulletin 93. **Apple maggot.** Keep windfalls picked up and destroyed or fed out. **San Jose Scale.** Apply whale oil soap, 2 lbs. to a gallon of water, when trees are dormant, or crude petroleum, 25 per cent. with kero-water or other pump, or kerosene and water in proportion of 1 to 5. Apply the soap or petroleum before buds start. See Bulletins 144 and 177.

Bean. **Anthracnose, pod-rust.** 1. Bordeaux mixture, when first true leaf has expanded; 2, 3, etc., the same at short intervals to keep the foliage covered by the mixture.

Beet. **Leaf-spot.** 1. When 4 or 5 leaves have expanded, Bordeaux mixture; 2, 3, etc., the same every 10 to 14 days.

Cabbage and Cauliflower. **Aphis.** 1. Upon young plants, kerosene emulsion, when insects are first seen; 2, repeat 1 when necessary or use tobacco water. **Cabbage-worm.** 1. If plants are not heading, kerosene emulsion or arsenites; 2, repeat 1 at intervals of 7 to 10 days; 2, if plants are heading, hellebore. **Plusia caterpillar.** Make very thorough application as recommended under *Cabbage-worm.* For **Root-maggot,** see Bulletin 78.

Carnation. **Anthracnose or spot.** 1. At first appearance of disease, Bordeaux mixture thoroughly applied in *fine* spray; 2, 3, etc., if plants are not blooming, Bordeaux mixture; ammoniacal copper carbonate to avoid staining the flowers. Keep foliage covered with a fungicide. **Rust.** Begin with healthy cuttings, spray the plants every week during their life with copper sulfate solution, 2 lbs. copper sulfate to 45 gallons of water, or with potassium sulfide solution. **Red Spider.** Syringe freely with clean water. Keep the atmosphere of the house moist.

Celery. **Early blight, late blight.** 1. Apply Bordeaux mixture as soon as the plants have become established; 2, repeat 1 every two weeks until the plants are half or two-thirds grown; 3, apply ammoniacal copper carbonate solution every 10 to 14 days, or more often if the weather is rainy.

Cherry. **Black-knot.** See PLUM. **Rot.** 1. When buds break, Bordeaux mixture; 2, when fruit has set, repeat 1; (3, when fruit is grown, ammoniacal copper carbonate). **Aphis.** 1. Kerosene emulsion when insects appear; 2, 3, repeat at intervals of 3 to 4 days if necessary. **Slug.** 1. When insects appear, arsenites or hellebore; 2, 3, repeat 1 in 10 to 14 days if necessary.

Chrysanthemum. **Leaf-spot.** Ammoniacal copper carbonate at intervals of 10 to 14 days, to keep the foliage protected. **Rust.** Treat as for *leaf-spot;* also wet the foliage as little as possible in watering the plants.

Cucumber and Squash. **Downy mildew.** Bordeaux mixture every 10 days, or often enough to keep the foliage well covered, from the time the plants are very small until frost. **Striped cucumber beetle.** Keep plants thoroughly covered with Bordeaux mixture. See Bulletin 144.

Currant. **Leaf-blight.** 1. When injury first appears, before the fruit is harvested, ammoniacal copper carbonate, to avoid staining the fruit; 2, after fruit is harvested, Bordeaux mixture freely applied; 3, repeat 2 when necessary. **Worm.** 1. When first larvæ appear, arsenites; 2, repeat 1 when necessary until fruit is half grown; 3, use hellebore if any worms remain after fruit is half grown.

Eggplant. **Leaf-spot.** As soon as plants are established in the field, Bordeaux mixture; 2, 3, repeat 1 at intervals of 2 to 3 weeks till first fruits are one-half grown; 4, ammoniacal copper carbonate, repeat when necessary.

Gooseberry. **Mildew.** 1. Before buds break, Bordeaux mixture; 2, when first leaves have expanded, potassium sulfide; 3, 4, etc., repeat 2 at intervals of 7 to 10 days, if necessary throughout the summer. **Currant worm,** see under CURRANT.

Grape. **Anthracnose.** 1. Before buds break in spring, sulfate of iron and sulfuric acid solution; 2, repeat 1 after 3 or 4 days to cover untreated portions. **Black-rot.** (1, as soon as first leaves are fully expanded, Bordeaux mixture); 2, after fruit has set, Bordeaux mixture; 3, repeat 2 at intervals of 2 to 3 weeks until fruit three-fourths grown; 4, ammoniacal copper carbonate when fruit is nearly grown; 5, 6, etc., repeat 4 at intervals of 7 to 14 days as required. **Downy mildew, Powdery mildew,** the first application recommended under **Black-rot** is of especial importance. See Bulletin 76. **Ripe-rot,** apply very thoroughly the later applications recommended under *Black-*

rot. **Steely-beetle.** 1. As buds are swelling, arsenites; 2, after 10 to 14 days, repeat 1. See Bulletin 157.

Nursery Stock. **Fungous diseases.** 1. When first leaves appear Bordeaux mixture; 2, 3, etc., repeat 1 at intervals of 10 to 14 days to keep foliage well covered. **Plant-lice.** Kerosene emulsion, kero-water, or tobacco water, apply thoroughly. **San Jose Scale.** Burn or fumigate. See under APPLE.

Peach, Nectarine, Apricot. **Brown-rot.** 1. Before buds swell, copper sulfate solution; (2, before flowers open, Bordeaux mixture); 3, when fruit has set, repeat 2; 4, repeat after 10 to 14 days; 5, when fruit is nearly grown, ammoniacal copper carbonate; 6, 7, etc., repeat 5 at intervals of 5 to 7 days if necessary. Pick off and destroy diseased fruit. **Curl-leaf.** 1. Before buds swell (March or April) use strong Bordeaux mixture; (2, as soon as petals have fallen, dilute Bordeaux; 3, when curled leaves begin to drop dilute Bordeaux).

Pear. **Blight.** Cut out all affected branches in fall before leaves drop; 2, repeat 1 whenever necessary during growing season. All branches should be cut 6 to 10 inches below point of infection; burn the parts. **Leaf-blight or Fruit-spot. Leaf-spot.** 1. Before blossoms open, Bordeaux mixture; 2, after blossoms have fallen, repeat 1; 3, 4, etc., repeat 1 at intervals of 2 to 3 weeks as appears necessary. For Leaf-spot in detail see Bulletin 145. **Scab.** See under APPLE. **Leaf-blister.** 1. Before buds swell in spring, kerosene emulsion, diluted 5 to 7 times. **Psylla.** 1. When first leaves have unfolded in spring, kerosene emulsion diluted 7 or 8 times, or whale-oil soap 1 lb. to 4 or 5 gallons of water; 2, 3, etc., at intervals of 2 to 6 days, repeat 1 until the insects are destroyed. See Bulletin 108. **Slug.** See under CHERRY. **San Jose Scale, Codlin-Moth.** See under APPLE.

Plum. **Brown-rot.** See under PEACH. **Leaf-blight.** (1. When first leaves have unfolded, Bordeaux mixture); 2, when fruit has set, Bordeaux mixture (dilute for Japanese plums); 3, 4, etc., repeat 2 at intervals of 2 to 3 weeks, use a clear fungicide after fruit is $\frac{3}{4}$ grown. **Black-knot.**

1. During first warm days of early spring, Bordeaux mixture; 2, repeat 1 when buds are swelling; 3, during latter part of May, repeat 1; 4, repeat 1 during middle of June (5, repeat 1 in July). Cut out knots. See Bulletin 81. **Curculio.** Spraying is not always satisfactory; jar the trees after fruit has set, at intervals of 1 to 3 days during 2 to 5 weeks. See Bulletin 131. **Plum Scale.** 1. In autumn when leaves have fallen, kerosene emulsion, diluted 4 times; 2 and 3 in spring, before buds open, repeat 1. See Bulletin 108. **San Jose Scale.** See under APPLE.

Potato. **Early Blight.** 1. When vines are young, Bordeaux mixture; 2 and 3, repeat 1 at intervals of 2 to 3 weeks (only partially successful). **Late Blight.** 1. During middle of July, Bordeaux mixture; 2 and 3, at intervals of 1 to 3 weeks, repeat 1. **Scab.** Soak uncut seed potatoes 1½ hours in solution of 1 ounce corrosive sublimate in 8 gallons water; or 2 hours in solution of ½ pint formalin in 15 gallons water. **Potato Beetle.** When beetles first appear, arsenites; 2 and 3, repeat 1 when necessary. **Flea-beetle.** Bordeaux mixture and Paris green.

Quince. **Leaf-blight or fruit-spot** (1. When blossom buds appear, Bordeaux mixture); 2, when fruit has set, repeat 1; 3, 4, etc., repeat 1 at intervals of two weeks, until fruit is ¾ grown; if later treatments are necessary, ammoniacal copper carbonate. See Bulletin 80. **Blight.** As for Pear. **Curculio.** Jar, as for Plum curculio. See Bulletin 148.

Raspberry, Blackberry, Dewberry. **Anthracnose.** 1. Before buds break copper sulfate solution, also cut out badly infested canes; 2, when growth has commenced, Bordeaux mixture; 3, 4, etc., repeat 2 at intervals of 1 to 3 weeks, avoid staining fruit by use of clear fungicide. (Partially successful). Badly infested plantations should be rooted out. **Orange-rust or Yellows.** Remove and destroy affected plants as soon as discovered. See Bulletin 100. **Saw-fly.** 1. When first leaves have expanded, arsenites; 2, after 2 to 3 weeks repeat 1, or apply hellebore.

Rose. **Black-spot.** Spray plants once a week with ammoniacal copper carbonate. **Mildew.** Keep heating pipes painted with equal parts lime and sulfur mixed with water to form a thin paste. Spray with copper fungi-

cides. **Aphis, Leaf-hopper.** Kerosene emulsion, whale oil soap or tobacco water applied to the insects' bodies at short intervals is effective. **Red Spider.** Apply fine spray of water to the foliage; keep house as damp as possible without injury to plants.

Strawberry. **Leaf-blight, Mildew.** 1. When growth begins in spring, Bordeaux mixture; 2, when first fruits are setting repeat 1; 3, after fruiting, or on non-bearing plants, Bordeaux mixture at intervals of 1 to 3 weeks. See Bulletin 79.

Tomato. **Leaf-blight.** 1. As soon as disease is discovered, Bordeaux mixture or a clear fungicide; 2, 3, etc., repeat 1 at intervals of 7 to 10 days. **Rot.** Spray as directed under *leaf-blight* (unsatisfactory in most cases). Usually better to secure many pickings by starting the plants early and giving the best culture: then if the rot comes, some pickings stand a chance of escaping. Train the vines.

FORMULAS.

Paris Green.

Paris green......................	1 pound
Water............................	100–300 gallons

If this mixture is to be used upon fruit trees, 1 pound of quick lime should be added. Repeated applications will injure most foliage, unless the lime is used. *Paris green and Bordeaux mixture can be applied together with perfect safety.* Use at the rate of 4 to 8 ounces of the arsenite to 50 gallons of the mixture. The action of neither is weakened, and the Paris green loses its caustic properties. For insects that chew.

London Purple.

This is used in the same proportion as Paris green, but as it is more caustic it should be applied with two or three times its weight of lime, or with the Bordeaux mixture. The composition of London purple is variable, and unless good reasons exist for supposing that it contains as much arsenic as Paris green, use the latter poison. Do not use London purple on peach or plum trees unless considerable lime is added. For insects that chew.

Arsenites of Lime and Soda.

These have the advantages of being cheap, the amount of arsenic is under perfect control and it does not burn the foliage. For chewing insects.

Arsenite of lime is made by boiling 1 pound white arsenic in 2 to 4 quarts water until it is dissolved, then use this arsenic solution to slack 2 pounds good lime, adding water if necessary to slack it; when slacked, add water enough to make 2 gallons of this stock mixture.

This may be kept in a tight vessel and used as desired. Thoroughly stir the material before using. For most insects one quart of the above to 40 gallons will be sufficient. Arsenite of lime is insoluble in water and will not injure the foliage of any orchard fruit at this strength. This insecticide is growing in popularity. Some green dye stuff may be mixed with it to prevent the ever-present danger of mistaking it for some other material.

Arsenite of soda. The arsenic (1 lb.) may also be boiled with 4 pounds of sal soda crystals in 2 gallons water until dissolved, and this solution used in the same manner (with lime). The arsenite of lime is cheaper, and either can be used with Bordeaux mixture the same as Paris green. When used with water, however, it will be safer to put in some freshly slacked lime.

Other Arsenites.

Green arsenoid and *Paragrene* are more bulky and finer than Paris green, and when of good quality they are just as effectual and require less agitation. *Arsenate of lead* can be applied in large quantities without injury to the foliage, hence it is very useful against beetles and similar insects that are hard to poison; it also adheres to the foliage a long time.

Normal or 1.6 Per Cent Bordeaux Mixture.

Copper sulfate (Blue vitriol)............	6 pounds
Quicklime (Good stone lime)............	4 "
Water....................................	50 gallons

For peaches and Japanese plums, an extra amount of lime should be added, and more water (60 to 70 gallons) should be used.

Six pounds of sulfate of copper dissolved in fifty gallons of water, when applied at the proper time, will prevent the growth of fungi. However, if applied in this form, the solution will burn the foliage. Four pounds of quicklime in six pounds of copper will neutralize the caustic action. When sulfate of copper and lime are added in this proportion, the compound is Bordeaux mixture.

Weighing of copper and lime at time of mixing is very inconvenient. Bordeaux mixture is best when used within a few hours after being mixed. Therefore a stock mixture of Bordeaux is impracticable. It is, however, practicable to have stock preparations of sulfate of copper and of lime ready for mixing when required.

The lime should be "dry slacked" in a barrel or box, and when slacked must always be covered with water to exclude the air. In this manner lime can be kept all summer unimpaired.

Sulfate of copper can be dissolved in water and held in solution until needed. One gallon of water will hold in solution two pounds of copper sulfate. To accomplish this the sulfate should be suspended at the surface of the water in a bag. The water most loaded with copper will sink to the bottom, and the water least loaded will rise to the surface. If fifty pounds of sulfate are suspended in twenty-five gallons of water on an evening, each gallon of water, will when stirred the next morning, hold two pounds of sulfate.

If three gallons of this solution are put in the spray barrel, it is equivalent to six pounds of copper. Now fill the spray barrel half full of water before adding any lime. This is important, for if the lime is added to so strong a solution of sulfate of copper, a curdling process will follow. Stir the water in the lime barrel so as to make a dilute milk of lime, but never allow it to be dense enough to be of a creamy thickness. If the latter condition, lumps of lime will clog the spray nozzle. Continue to add to the mixture this milk of lime so long as drops of ferrocyanide of potassium (yellow prussiate of potash) continue to change from yellow to a brown color. When no change of color is shown, add another pail of milk of lime to make the necessary amount of lime a sure thing. A small excess of lime does no harm. The barrel can now be filled with water, and the Bordeaux mixture is ready for use.

The preparation of ferrocyanide of potassium for this test may

be explained. As bought at the drug store, it is a yellow crystal and is easily soluble in water. Ten cents' worth will do for a season's spraying of an average orchard. It should be a full saturation; that is, use only enough water to dissolve all the crystals. The cork should be notched or a quill inserted so that the contents will come out in drops. A drop will give as reliable a test as a spoonful. The bottle should be marked "Poison." Dip out a little of the Bordeaux mixture in a cup or saucer, and drop the ferrocyanide on it. So long as the drops turn yellow or brown on striking the mixture, the mixture has not received enough lime.

Ammoniacal Copper Carbonate.

Copper carbonate	5 oz.
Ammonia (26° Beaumé)	3 pints
Water	45 gals.

Make a paste of the copper carbonate with a little water. Dilute the ammonia with 7 or 8 volumes of water. Add the paste to the diluted ammonia and stir until dissolved. Add enough water to make 45 gallons. Allow it to settle and use only the clear blue liquid. This mixture loses strength on standing. For fungous diseases.

Copper Sulfate Solution.

Copper sulfate	1 pound
Water	15–25 gallons

Dissolve the copper sulfate in the water, when it is ready for use. *This should never be applied to foliage but must be used before the buds break.* For peaches and nectarines, use 25 gallons of water. For fungous diseases, but now largely supplanted by the Bordeaux mixture. A much weaker solution has been recommended for trees in leaf.

Iron Sulfate and Sulfuric Acid Solution.

Water (hot)	100 parts
Iron sulfate, as much as the water will dissolve.	
Sulfuric acid (commercial)	1 part

The solution should be prepared before using. Add the acid to the crystals, and then pour on the water. Sometimes recommended

for grape anthracnose, the dormant vines being treated by means of sponges or brushes, but it should be applied with caution.

Potassium Sulfide Solution.

Potassium sulfide (Liver of sulfur)	$\frac{1}{2}$–1 oz.
Water	1 gallon

This preparation loses its strength upon standing, and should therefore be made immediately before using. Particularly valuable for surface mildews.

Hellebore.

Fresh white hellebore................	1 ounce
Water................	3 gallons

Apply when thoroughly mixed. This poison is not so energetic as the arsenites, and may be used a short time before the sprayed parts mature. For insects which chew.

Kerosene Emulsion.

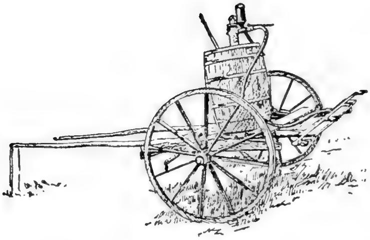
Hard soap.	$\frac{1}{2}$ pound
Boiling soft water......................	1 gallon
Kerosene	2 gallons

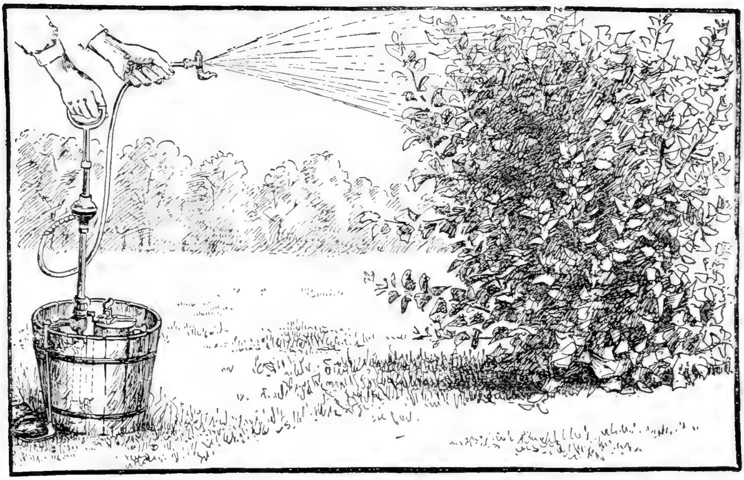
Dissolve the soap in the water, add the kerosene, and churn with a pump for 5 to 10 minutes. Dilute 4 to 25 times before applying. Use strong emulsion for all scale insects. For such insects as plant lice, mealy bugs, red spider, thrips, weaker preparations will prove effective. Cabbage worms, currant worms and all insects which have soft bodies can also be successfully treated. It is advisable to make the emulsion shortly before it is used.

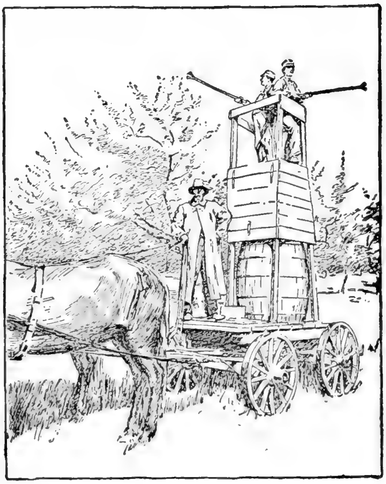
Kerosene and Water (suggested for San José scale -- see under *Apple*) may be used in all cases where kerosene emulsion is mentioned. Dilute to the strength recommended in each particular case. It must be applied with a pump having a kerosene attachment.

Tobacco Water.

This solution may be prepared by placing tobacco stems in a water-tight vessel, and then covering them with hot water. Allow to stand several hours, dilute the liquor from 3 to 5 times, and apply. For soft bodied insects.







Bulletin 189. **April, 1901.**

Cornell University Agricultural Experiment Station,

ITHACA, N. Y.

HORTICULTURAL DIVISION.

OSWEGO STRAWBERRIES.

AN ACCOUNT OF EXPERIMENT WITH FERTILIZERS, AND RECORDS OF STRAWBERRY-GROWING, IN THE OSWEGO DISTRICT.

By L. H. BAILEY.

PUBLISHED BY THE UNIVERSITY,

ITHACA, N. Y.

1901.

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The regular bulletins of the Station are sent free to all persons residing in New York State who request them.

Cornell University,
Ithaca, N. Y., *April* 15, 1901.

The Honorable Commissioner of Agriculture, Albany:

Sir.— This bulletin is the record of extension experiment work done under the auspices of the State appropriation, in fertilizing strawberry fields. The work was undertaken upon request of the Oswego berry growers, whose commercial interests in strawberries are large. The experiments were begun in 1897 and are still continuing. Of the various tests that have been made, 64 are reported herewith. The object of the experiments is to determine what fertilizers it pays to use on strawberry fields under general commercial conditions. It is not to be expected that this question can ever be finally answered, for each field is a law unto itself; yet the experiments show that in the Oswego district and under the good culture given by the best berry growers, heavy applications of nitrogen are not required and that mineral fertilizers conduce to the solidity and quality of the fruit as well as to productiveness.

On request of leading berry growers, a short historical sketch is also given of the Oswego strawberry business.

I. P. ROBERTS,
Director.

31.— *A field of Marshall strawberries grown by F. G. Tice, illustrating the "narrow hedge-row system" of planting.*

32.— *Market scene in the strawberry season in Oswego.*

I. SUMMARY OF FIELD RESULTS WITH THE USE OF FERTILIZER ON STRAWBERRIES.

In the spring of 1897, at the request of the Oswego County Fruit-growers' Association, the Horticultural Department of Cornell University planned, and now has under way, a series of tests with different fertilizers for the purpose of determining, if possible, the one best suited to the needs of the strawberry when grown as a field crop. These experiments were begun by the late E. G. Lodeman, and they have been continued under the personal supervision of C. E. Hunn.

The three essential fertilizers, nitrogen, phosphoric acid and potash, were used separately and in combinations in different weights and seasons, careful notes being taken both as to growth of plant and yield of fruit. The fertilizers were applied to young plantations in spring after the first tillage and before the plants bloomed, a year in advance of the recorded crop. The materials were scattered alongside the row, within a few inches of the plants, and were cultivated in. The plats were located on a variety of soils, ranging from typical strawberry soil, *i. e.*, gravelly loam, through meadow land to black muck.

In 1897, in coöperation with the Association, six plats, in as many different localities, were selected and a careful line of experiments was planned. But five of these beds were continued through the year, the sixth having been disturbed by the digging of plants for sale. Tables 1 to 5, inclusive, give the results of the first year's work (1897).

The second year (1898) the plats were reduced to three in number, one on good strawberry soil, one on meadow land, and one on good wheat land. Tables 6 to 8, inclusive, give results of the second year's work. In 1899, no experiments were made. In 1897 and 1898, the plats were of various sizes, but in the tables below (Nos. 1–8) the fertilizers and yields are figured to the acre.

The third year (1900), in order to have all conditions as nearly perfect as possible, the Department made arrangements to control a one-acre plat of strawberries in three different localities. With this area it was possible to have larger tests and to control cultivation. These plats are given as tables 9 to 11, inclusive.

EXPERIMENT No. 1 (1897).

J. K. PROSSER, Oswego.

SOIL GRAVELLY LOAM, TWO YEARS FROM MEADOW. SEASON FAIRLY DRY.

Plat I. 200 lbs. wood ashes. Yield, 5,891 quarts.
Plat II. 400 lbs. wood ashes. Yield, 6,535 quarts.

(Plat II shows a gain of 644 quarts over Plat I. This at 5 cents per quart is an increase of $32.20, at an expenditure of $1).

Plat III. 300 lbs. muriate potash. Yield, 6,601 quarts.
Plat IV. 600 lbs. muriate potash. Yield, 7,393 quarts.
Plat V. 900 lbs. muriate potash. Yield, 8,383 quarts.

(Plat V shows, in comparison with Plat III a money gain of $89.10 at 5 cents per quart, for an outlay of $12.50.)

EXPERIMENT No. 2 (1897).

J. B. CHURCHILL, Scriba.

SOIL GRAVELLY GARDEN. SEASON FAIRLY DRY.

Plat I. 500 lbs. dissolved rock. Yield, 6,227 quarts.
Plat II. 1,000 lbs. dissolved rock. Yield, 7,322 quarts.

(Plat II shows a gain of 1,095 quarts. At an expense of $10, an added value of $54.75 was secured.)

Plat III. 500 lbs. muriate potash. Yield, 6,909 quarts.
Plat IV. 250 lbs. nitrate soda. Yield, 6,289 quarts.
Plat V. 250 lbs. muriate potash,
250 lbs. nitrate soda. Yield, 7,094 quarts.

(Gain with potash and muriate together 805 quarts. At 5 cents per quart, $40.25.)

EXPERIMENT No. 3 (1897).

G. F. GUYLE, Scriba Corners.

VERY STONY, APPARENTLY DEFICIENT IN HUMUS. SEASON FAIRLY DRY.

Plat I. 500 lbs. muriate potash. Yield, 4,286 quarts.
Plat II. 500 lbs. sulfate potash. Yield, 4,044 quarts.
Plat III. 500 lbs. dissolved rock. Yield, 5,558 quarts.
Plat IV. 250 lbs. muriate potash,
250 lbs. nitrate soda. Yield, 6,313 quarts.
Plat V. 250 lbs. sulfate potash,
250 lbs. nitrate soda. Yield, 5,357 quarts.

EXPERIMENT No. 4 (1897).

A. D. BUTTON, New Haven.

SOIL RICH BOTTOM LAND. SEASON FAIRLY DRY.

Plat I. 350 lbs. dissolved rock. Yield, 13,597 quarts.
Plat II. 700 lbs. dissolved rock. Yield, 20,066 quarts.
(At an expense of $7 there was a gain of $353.55 over Plat I.)

EXPERIMENT No. 5 (1897).

GEORGE A. DAVIS, Mexico.

SOIL HEAVY MUCK WHICH APPARENTLY CONTAINED SUFFICIENT NITROGEN. SEASON FAIRLY DRY.

Plat I. 300 lbs. nitrate soda,
300 lbs. muriate potash,
300 lbs. dissolved rock. Yield, 7,382 quarts.
Plat. II. 300 lbs. muriate potash,
300 lbs. dissolved rock. Yield, 6,828 quarts.
Plat III. 300 lbs. nitrate soda,
300 lbs. dissolved rock. Yield, 6,159 quarts.
Plat IV. 300 lbs. nitrate soda,
300 lbs. muriate potash. Yield, 5,156 quarts.

Plat V. 500 lbs. nitrate soda,
300 lbs. muriate potash,
300 lbs. dissolved rock. Yield, 7,059 quarts.

Plat VI. 300 lbs. nitrate soda,
500 lbs. muriate potash,
300 lbs. dissolved rock. Yield, 8,708 quarts.

EXPERIMENT No. 6 (1898).

J. K. PROSSER, Oswego.

SOIL GRAVELLY LOAM. SEASON WET.

Plat I. 675 lbs. muriate potash. Yield, 5,424 quarts.

Plat II. 675 lbs. dissolved rock. Yield, 5,326 quarts.

Plat III. 200 lbs. nitrate soda,
675 lbs. muriate potash. Yield, 4,580 quarts.

EXPERIMENT No. 7 (1898).

BYRON COON, Scriba.

SOIL STONY, BUT WITH SUFFICIENT HUMUS. SEASON WET.

Plat I. 500 lbs. dissolved rock,
300 lbs. muriate potash. Yield, 6,920 quarts.

Plat II. 500 lbs. dissolved rock,
300 lbs. sulfate potash. Yield, 6,789 quarts.

Plat III. 400 lbs. dissolved rock,
400 lbs. muriate potash. Yield, 7,418 quarts.

EXPERIMENT No. 8 (1898).

GEORGE A. DAVIS, Mexico.

SOIL GOOD WHEAT LAND. SEASON WET.

Plat I. 800 lbs. muriate potash,
575 lbs. nitrate soda. Yield, 4,403 quarts.

Plat II. 800 lbs. sulfate potash. Yield, 4,023 quarts.
Plat III. Check. Yield, 2,926 quarts.
Part IV. 800 lbs. dissolved rock,
575 lbs. nitrate soda. Yield, 3,568 quarts.
Plat V. 400 lbs. dissolved rock,
575 lbs. nitrate soda. Yield, 3,282 quarts.

EXPERIMENT No. 9 (1899–1900).

BYRON COON, Scriba.

1 ACRE. SOIL VERY POOR AND STONY. SEASON VERY DRY.

Plat I. Manure; 2,000 lbs. ashes. Yield, 650 quarts.
Plat II. 5,000 lbs. ashes. Yield, 540 quarts.
Plat III. Check. Yield, 280 quarts.
Plat IV. 1,000 lbs. sulphate potash. Yield, 350 quarts.
Plat VII. 1,000 lbs. dissolved rock; manure. Yield, 990 quarts.
Plat VIII. Check. Yield, 120 quarts.
Plat IX. 2,000 lbs. dissolved rock. Yield, 870 quarts.
Patl X. 2,000 lbs. gypsum. Yield, 430 quarts.

EXPERIMENT No. 10 (1899–1900).

GEORGE A. DAVIS, Mexico.

1 ACRE. SOIL VERY STONY, BUT STRONG CORN LAND. SEASON VERY DRY.

Plat I. 5,000 lbs. ashes. Yield, 5,470 quarts.
Plat II. 15 tons manure; 2,000 lbs. ashes. Yield, 5,350 quarts.
Plat III. Check (no fertilizer) Yield, 2,660 quarts.
Plat IV. 1,000 lbs. sulfate potash. Yield, 2,970 quarts.
Plat V. 1,000 lbs gypsum. Yield, 2,590 quarts.
Plat VI. 1,000 lbs. dissolved rock,
1,000 lbs. muriate potash. Yield, 3,970 quarts.
Plat VII. Manure; 1,000 lbs. dissolved rock. Yield, 3,650 quarts.
Plat VIII. Check. Yield, 2,630 quarts.

Plat IX. 2,000 lbs. dissolved rock. Yield, 3,050 quarts.
Plat X. 1,000 lbs. muriate potash. Yield, 2,550 quarts.

EXPERIMENT No. 11 (1899–1900).

C. B. COOK, Oswego Center.

1 ACRE. SOIL FROM GRAVELLY TO GARDEN LOAM. SEASON VERY DRY.

Plat I. Manure; 2,000 lbs. ashes. Yield, 3,660 quarts.
Plat II. 5,000 lbs. ashes. Yield, 1,770 quarts.
Plat III. Check. Yield, 1,610 quarts.
Plat IV. 1,000 lbs. sulfate potash. Yield, 1,390 quarts.
Plat V. 1,000 lbs. muriate potash. Yield, 1,420 quarts.
Plat VI. 1,000 lbs. muriate potash,
1,000 lbs. dissolved rock. Yield, 1,780 quarts.
Plat VII. Manure; 1,000 lbs. dissolved rock. Yield, 3,170 quarts.
Plat VIII. Check. Yield, 1,540 quarts.
Plat IX. 2,000 lbs. dissolved rock. Yield, 2,410 quarts.
Plat X. 2,000 lbs. gypsum. Yield, 1,540 quarts.

REMARKS ON THE FOREGOING RESULTS.

These tables of yields show, as would be expected, a few conflicting results, but through the three years' tests the benefit of using both potash and phosphoric acid may readily be seen, as also the fact that, in most cases, when commercial nitrogen was used, the returns in fruit failed to pay for the outlay.

The benefits derived from the use of potash or phosphoric acid are not only the increase in yields, but these materials had a tendency to harden the fruit, and to give them a richer color. In every case where these have been used, the grower reports firmer and better colored berries, which means better shippers and better sellers.

It will be seen by a study of Exp. 1 that when an increase from 200 to 400 pounds of wood ashes was made, at a cost of not exceeding one dollar, the yield was greater by 640 quarts than when only

200 pounds had been used. This yield, figured at five cents per quart, would mean a gain of $32.20. In the same table, the increase from 300 to 900 pounds of muriate of potash was money well invested. The first increase from 300 to 600 pounds, at a cost of $6.20, shows a gain in yield of 792 quarts with a money gain at five cents a quart of $36.90. Again, increasing the amount of potash 300 pounds, making 900 pounds per acre at an increase in cost of but $12.50, the gain in fruit is shown to be 1,782 quarts, and the money gain $89.10.

In Exp. 2 the result of increasing from 500 to 1,000 pounds of dissolved rock, at a cost of not over ten dollars, was a cash gain of $54.65. Nitrate of soda used alone gave a yield of 800 quarts per acre less than when the same weight of muriate of potash was used with it.

Exp. 3. These results would tend to show that the soil had a large amount of available potash and was benefited by the application of nitrate of soda.

Exp. 4 shows a phenomenal yield in both cases, and an almost incredible increase when then the dissolved rock was doubled, at an expenditure of a comparatively small amount of money. Each of these plats was one-tenth of an acre in area — large enough to be of value as to an average — and the yield is well authenticated.

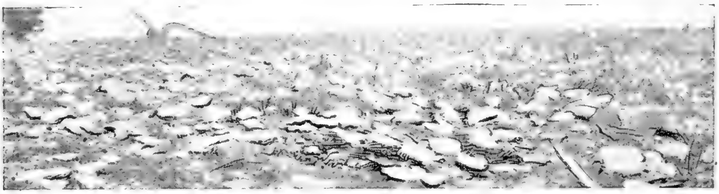
Exp. 5. This test was on low muck land and will well repay a careful study. Notice that where nitrate of soda was increased from three to five hundred pounds, the yield did not equal the first, but where muriate of potash was increased from three to five hundred pounds (Plats 1 and 5), the yield was raised over one thousand quarts. On Plat 5 there was too much growth of vine; the berries were soft and not equal in quality and firmness to those on the other plats.

Exp. 6 shows no practical difference between the use of potash or phosphoric acid, but it does show that the addition of nitrate of soda was of no benefit.

Exp. 7. This table shows a fairly well balanced fertilizer, each plat yielding considerable above the average per acre. The muriate of potash, however, shows to better advantage than the sulfate, a result that is to be seen in other tables as well.

Exp. 8. The land on which this experiment was made evidently needs potash, the nitrate of soda and dissolved rock plats yielding almost one thousand quarts less per acre than the potash in combination with nitrate of soda or than the potash alone. The small yield in Experiment No. 8 was no doubt due in great part to the fact that the fertilizer was received late and was not applied until August before the fruiting. The succeeding crop of wheat showed that the berries did not get all the fertilizer, for the wheat was much better on the fertilizer plats.

Exp. 9 represents an acre plat selected because of its known history, it being a rather stony pasture that had never been plowed and was so poor that the owner said it was practically worthless. The sod, which was very thin, was turned under early in the spring, the large stones removed, the ground thoroughly fitted and planted.



33.—*Stony land, before clearing for strawberries. This land gives excellent results. Experiment No. 10 was made on this land.*

Clean cultivation was given throughout the growing season, and a mulch of straw was given in November. Unfortunately, the fertilizer applied to Plats 5 and 6 was sown too close to the plants, destroying almost every one, thus causing those plats to be left out of the experiment. As would be expected from the condition of the land and the further handicap of an extremely dry season throughout the plant-making period, the yields on every plat were very small, but the benefit of using dissolved rock may readily be seen, as may also the use of manure used on Plats 1 and 7. These Plats 1 and 7 made more plants, resisted the drought better and were marked for the largest yield; but the fruiting season showed that Plat 9 had the material in the soil to produce not as many berries as Plat 1, but much larger ones.

Exp. 10. This experiment would seem to show that ashes were

by far the best of any fertilizer used, but an explanation of the conditions will modify the conclusions. Plats 1 and 2 were next to a four-foot stone fence, sheltered from the cold winds of fall and spring, being covered with a good coat of snow through the winter months. Added to this was the fact that the May beetles in flying from an adjoining pasture field did not settle to the ground until they had passed the space where these plats were subsequently planted. The ground was practically clear of grubs which were quite destructive in the remainder of the plats, especially so on the one-half of the acre containing Plats 6 to 10 inclusive. This being the case, dissolved rock again shows its value. On Plat 2 fresh cow manure was applied at the rate of 30,000 pounds to the acre before the plants were set, resulting in much more growth than on the other plats; the berries, however, were not as good as on the fertilizer plats.

Experiment 11. This table shows in a less degree the same conditions as in Table 10. Plat 1, having a more sheltered position and being lower than the remainder of the bed, had the benefit of more moisture through two dry seasons, that of plant-growing and that of fruiting. Otherwise the results are in accord with those of the larger part of these tests.

GENERAL CONCLUSION.—*The first striking fact about these tests is the high yield of the fertilizer plats. Omitting Experiment 9, in which part of the plants were killed by the fertilizer and in which the soil was very poor and stony, the average yield from 55 tests was 5,197 quarts per acre, or 2,000 quarts above the average. The second general result is the superiority of potassic and phosphoric fertilizers as compared with the nitrogenous. The nitrogen fertilizers, including very heavy applications of stable manure, gave too much growth and an inferior quality of fruit. It must be remembered, however, that these strawberry growers are good cultivators and that their tillage probably supplied sufficient nitrogen in most cases.*

TESTIMONY OF THE GROWERS.

In order to ascertain the farm value of these experiments, the following questions were asked of four of the growers who had charge of the experimental work:

1. Did the use of fertilizers of any kind increase the yield?
2. Did they add to the firmness of the fruits?
3. Did they add to the color of the fruits?
4. Do you use commercial fertilizer every year?

Grower No. 1 writes in reply to these questions:

1. Yes.
2. Yes, if used in proper quantities.
3. Same answer as for 2.
4. Yes; cannot get good stand of vines without it.

Grower No. 2 writes as follows:

1. Yes.
2. Yes, by the use of dissolved rock and potash.
3. I could not say.
4. I shall do so in the future. Have just had a lot put up of fifteen per cent phosphoric acid and ten per cent muriate of potash.

This grower further says: "I am much in favor of the use of phosphoric acid, but I used a bone and potash fertilizer last year applied in the fall with good results. I have taken the lead in yield and large fruits at this place for the past two years."

Grower No. 3 says in answer:

1. The yield was twice as great as when no fertilizer was used.
2. The fruits were firmer where fertilizers were used; in fact, no claim was made by commission men that any of the fruit was soft. However, where the nitrate of soda was used the fruit was softer than where the other applications were made. Further, my experience in growing strawberries has convinced me that nitrate of soda is not necessary here.
3. Where potash and phosphoric acid were used, the fruits were better colored and better flavored than when nitrate of soda was used. I shall never buy any more nitrate of soda for strawberries. Neither shall I use green manure in the soil before the plants are set.
4. It pays to use commercial fertilizer on strawberries. The application may be made before the plants are set, early in the season after they are set, or during winter when the plants are in a dormant condition.

Grower No. 4 replies: "I got a bigger yield by using the fertilizer, and the berries were firmer and better color. My neighbor next to me had the same kind of berries (Atlantic), and he said my berries sold from three to six cents a quart more than his did."

TESTIMONY OF THE CHEMIST.

When fertilizer experiments are under way one naturally consults the chemist. One wants to know the chemical nature of the soil. The services of the Assistant Chemist of the Experiment Station, G. W. Cavanaugh, were, therefore, secured in these Oswego strawberry investigations. He was asked to analyze the soils. He visited the region, inspected the experiments, took samples, and submitted the following report:

If the application of the various forms of plant-food was the determining factor in the productivity of a soil we might well expect definite results from experiments with commercial fertilizers. It is the experience, however, of those who have conducted such experiments that the results are often at variance. Here one substance tends to increase a crop, and there the same substance seems to have the opposite effect. In some cases that the writer has seen the check or blank plat yielded more than those fertilized.

When it is a question of restoring or maintaining the productivity of a soil, there are other points to be considered than the application of fertilizers. These points are fully as important as the presence or absence of the small amount of plant-food contained in the average fertilizer application.

1st. The physical condition or tilth.

A good physical condition is necessary to the plants to enable them to obtain the necessary root growth, and to permit more even distribution of the fertilizer. The very preparation given in bringing about this condition goes a long way in unlocking the identical constituents that are later to be applied. This desirable condition is not to be had in a soil that needs drainage or has a hard-pan too near the surface. If the soil is in a rough condition, full of clods, as sometimes happens in clay soils, it is difficult to properly distribute the fertilizer. In general the better the tilth the more of the fertilizer applied will be available.

2d. Fertilizers do not take the place of humus in soils.

The commercial fertilizers consist principally of phosphates of lime (mineral), salts of potash (mineral), and some form of combined nitrogen. The two chief sources for available nitrogen are nitrate of soda (mineral) and dried blood (animal). This dried blood, and frequently tankage, are the only substances that would tend to keep up the humus or mold in the soil.

The virgin soil was rich in humus from the fallen leaves of centuries. Under the influences of air, heat and moisture this humus decayed. The products of this decay furnished not only available nitrogen to the plant, but also part of the necessary mineral substances. The rock part of the soil also gave up some of its mineral plant-food through the decay of the humus. The presence of humus is necessary for the best physical condition or tilth. The soil on which the yields tabulated in Experiment 9 were obtained contained very little humus. This deficiency of humus, and not the quality of the fertilizer, accounts for the relatively low yield.

The amount of moisture stored in the soil, or brought to it by rains, is a more potent factor than the mere adding of plant-food. This is well illustrated by Experiment 10, where the snow protected Plats 1 and 2, and stored more water in the soil.

On account of these various influences there is not necessarily a direct relation between the composition of the soil and some particular substance the application of which will increase fertility. The chemical composition is only one of several important factors that are concerned in productivity. It is the factor least under man's control, and the one to which he should last resort; yet, the addition of commercial fertilizer may sometimes give most profitable results.

II. GENERAL SKETCH OF THE OSWEGO STRAWBERRY INDUSTRY.

Oswego is the center of the most important strawberry industry of New York State. The leading natural advantages of this region for the commercial production of strawberries is the lateness at which the crop matures. When the berry season of New Jersey and southern New York is past, the Oswego berries are in their prime. The lateness of the crop is still further emphasized in the selection of late varieties, as Atlantic, Parker Earle and Gandy. The season opens about June 20th and continues for three weeks.

Oswego lies at the south-eastern corner of Lake Ontario. The climate of the region is tempered by the lake, and the soil is well adapted to many kinds of fruits. Next to strawberries, pears are the leading fruit crop, and plums and other fruits are prominent. It is at Minetto, in this region, that Schuyler Worden originated the Worden grape and the Worden pear. From Oswego as a center, the fruit interests have spread until most towns in the county (of Oswego) are now producing fruit to an important extent. To the same geographical region belongs the town of Sterling, comprising that part of Cayuga county lying on Lake Ontario. The Oswego strawberry district, therefore, is an area of considerable geographical extent.

Some Field Notes on Oswego Methods.

In a region in which a special industry has developed, expert and advanced commercial methods are necessarily to be found. A word may be said in regard to two or three of the points in the Oswego practices.

The question is often asked — What does it cost to grow an acre of strawberries? In order to answer this question a number of good growers in the Oswego region were asked for figures of actual cost, and the replies form the basis of the following table:

Rent of land, two years	$11 00
Plowing and fitting	6 00
Plants	15 00
Setting plants	4 00
Cultivation	16 00
Straw for winter and fruiting mulch	15 00
Labor — hoeing, pulling weeds, etc	10 00
Total cost	$77 00

Many growers raise berries at a much less cost, and a few exceed this sum especially when located near a large town where rents are high; but it would be safe for one about to engage in strawberry growing to figure close to this total, aside from the cost of fertilizer.

As to methods of planting, it may be said that the old method has been discarded,— planting in rows three to three and one-half feet apart and the plants from twelve to fifteen inches apart in rows, keeping off the runners until late in July and then allowing the runners to grow and root at will making a matted row. In this old system many plants are almost on top of others, the roots barely in the ground, and they suffer in a season of drought. The rows are so wide that to pick fruit in the center it is almost necessary to crush fruits on the outside of the row. This system gives few large first-class fruits. The up-to-date grower starts with the assumption that the largest and highest colored fruits are found on plants along the outside of the rows, and therefore he plans to have as many outside rows as possible. This he accomplishes by having his rows closer together and much narrower. The rows are made from thirty to thirty-six inches apart and the plants from eighteen to twenty-four or even thirty inches apart in the rows, much depending on the capability of the variety as a plant-maker. If the plants used for a new bed are strong and start into growth vigorously, the first runners are used, as it has been found that under most conditions the plants about twelve months old yield the greatest number of fine fruits. These first runners are usually "bedded in," i. e., planted by hand, training them along the wide way of the rows, using from four to eight of the first runners and cutting off those growing later. This method of planting allows cultivation both ways until the runners start, retaining moisture and saving labor in hoeing.

Clean straw or swale grass makes the best winter mulch. The rows are covered two to four inches deep. This winter mulch should be raked from the plants and left between the rows as a protection to the fruits and a safeguard against drought in the fruiting season.

The use of well-rotted manure, plowed under when fitting the land for plants, gives the best of results in many cases. Especially is this the case when a dry growing season occurs, the plants being able at once to obtain available plant-food and growing without a check and making runners early in the season. In many soils the manure adds the needed humus. Green or half-rotted manure is more often an injury than a benefit because of the many weed seeds it contains. Many strawberry beds are practically ruined by the weeds introduced by the use of such manure. Perhaps the better method of using manure is to apply it rather heavily to the crop grown on the land the year before strawberries are planted, following that crop with a cover-crop to be turned under in the spring before setting plants.

The best growers are always experimenting, and as a result many special practices have developed. One of these, by George A. Davis, will serve as a type: "Last year I marked a three-acre piece $3\frac{1}{4}$ x 4 ft., setting two plants nine inches apart at each crossing. I cultivated the piece both ways until the plants became numerous enough so that there was risk of destroying them. Then cultivation was continued only one way. The plants were then bedded in the narrow way ($3\frac{1}{2}$ ft.), and the cultivator was only run lengthwise (in 4 ft. space), gradually narrowing the cultivator as the plants became more numerous.

"By this method (two plants in a place) there is (1) less risk of waste ground, that is, if a grub eats one there still remains a plant to fill the space; (2) there is more space for pickers; (3) cultivator saves expense in hoeing; (4) new plants root much more readily when the soil has been cultivated than in the single matted rows."

Historical Sketch of the Oswego Strawberry Business.

The Oswego fruit-growers have desired that we put on record a synopsis of the development of the strawberry industry in their

region. This we are glad to do, because we believe that such histories should be preserved, that they add dignity to agriculture, and that they inspire interest and confidence in the business. These records have been compiled for us by many persons, some of whose names appear below and to all of whom we desire to express our gratitude. We are under particular obligation to the officers of the transportation companies, and to George A. Davis, Mexico, Oswego County, for the statistics of strawberry shipments.

"*History by D. T. McInerney, Agt. American Express Co., Oswego.*—The strawberry business of Oswego County came into existence in 1863, when Morris Pierce brought into the city of Oswego a few quarts of cultivated strawberries and placed them on sale at the stand of Thos. Hart to be gazed at as a curiosity by hundreds of persons and sold at one cent per berry. The price realized and the interest created so stimulated the new born industry that Wm. Adams, Seymour Coe, Justin Janny, W. J. Stark and a few others commenced the cultivation of strawberries to the extent of about 100 quarts per season each, and prices assumed a more natural tone.

"In 1866, the first shipments were made from Oswego, and went by boat to Ogdensburg, N. Y., Kingston, Ont., and Montreal, and by rail to Watertown and Syracuse, N. Y. The varieties grown were the Scarlet and the Wilson. For shipment to Canadian ports and Ogdensburg the berries were put up in crates about four feet square, requiring four men to handle. These crates held about 300 quarts.

"In 1868, the trade extended to Rome, Utica and Albany, and prices realized were about 6 cents per quart, the style of crate changing to a 45-quart and a 90-quart.

"In 1872, the strawberry growing extended to other parts of the county east of Oswego city, and trade was opened with New York city. The first strawberries sent to New York were shipped in 1872, by express in about 100 crates, over the D., L. & W. R. R., at a cost of $1.00 per crate for transportation.

"In 1873, J. Heagerty sent 100 crates to Philadelphia by tug to Fair Haven, N. Y., thence by Lehigh Valley R. R. A coöperative association was formed by the growers in 1876, by which a special

train was sent to New York from Oswego via D., L. & W. R. R. The attempt was badly managed, and ended in failure, the cost of transportation exceeding the price of berries in New York by 3 cents per quart.

"There were about 500 crates a season shipped in 1878 to 1880, but about this time E. P. Loomis and A. Bennett & Co. of New York instituted service of refrigerator cars to New York and J. Heagerty arranged a similar one on the R., W. & O. and N. Y. C. for New York, and another on the D., L. & W. for Philadelphia.

"Active competition in buying between J. K. Lynch and J. Heagerty, together with the fact that Oswego County strawberries were recognized on the New York and Philadelphia markets as possessing a flavor and solidity unequalled, stimulated the business to total shipments of 2,000 crates per season to New York and 1,000 crates to Philadelphia in 1883. The price averaged 7 cents per quart net. In 1884 Oswego County strawberries went into Newark, N. J., via D., L. & W. R. R.

"The year 1888 was the first in which J. Heagerty, assisted by J. W. Lyon, arranged refrigerator service by R., W. & O. R. R. to Sterling, thence by Lehigh Valley R. R. to Philadelphia, instead of by D., L. & W. R. R. The National Ex. Co. placed a service on the O. & W. R. R. to New York in 1891 and 1892, carrying 3,000 crates, but it was succeeded by the Adams Ex. Co. on that line. The American Express Co., with special trains of refrigerator cars, made a good record to New York and opened a most important market with Boston. In this year there were two express companies and one freight line carrying to New York and two freight lines carried to Philadelphia, the Pennsylvanians having entered the race. The total quantity shipped from the county was 12,000 36-quart crates and the average price received was 8 cents per quart.

"Through the impetus of the newly opened Boston market, the acreage of the strawberry district enlarged in 1894, and in that year nearly all that went to New York was carried by American Ex. Co. The total number of 36-quart crates shipped from Oswego County was 15,000, to all points, and the average price received was 9 cents per quart. The acreage was further increased, and in 1895 car loads were shipped by J. Heagerty to Buffalo, Cleveland and Chicago by

American Express Company. B. Johnson also shipped by that company to the latter points. The berries arrived in good order and sold satisfactorily. The New York, Newark, Philadelphia and Boston market took large quantities. Twenty thousand 36-quart crates were shipped and an average of 10 cents per quart was received.

"The profitable experience of growers in 1893, 1894 and 1895 resulted in increased care and cultivation and more acres devoted to strawberry raising, with more good berries to the acre than ever before. A publication by the American Express Company giving addresses of growers and shippers was distributed in all important points in the United States, and in 1896 the demand for strawberries exceeded the supply, and western buyers could not be supplied. Best quality berries sold a $7.00 per 36-quart crates in Oswego; 22,000 crates were shipped from the county. The average price received was 12 cents per quart. In June an exhibition was held under the direction of the late Jas. Hart at Hart's place, in Oswego, at which the "strawberries of our daddies," size of a pea, and "Gandy prizes," four inches in circumference, were shown.

34.— *Strawberries packed for fancy market. The quart boxes are wrapped in paraffine paper.*

"In the year 1899, in response to efforts made by the agents of the American Express Co., Pittsburgh, Pa., Buffalo, N. Y., Worcester, Mass., and Auburn, N. Y., were added to the list of markets for Oswego berries. In consequence of this additional stimulation, men who had become discouraged many years ago returned to the growing of strawberries, being made to realize at last that a demand has been created for their kind of berries that far exceeds the supply.

More enthusiasm was manifested by everybody. A. Bennett & Co., who did the business to N. Y. in 1878 through J. K. Lynch, sent A. Fletcher as a representative, who has since continued to buy actively through J. K. Lynch, Jr., of Oswego. F. G. Tice placed some of his superb berries in a neat case-like tray, exhibited them to appreciative people, received large orders, shipped on early forenoon express trains without ice to preserve the flavor and received remunerative reward for his enterprise. T. Halloway & Co., Boston, and Bennett & Hall, competed actively for extra fine Atlantics produced by J. K. Prosser; then his neighbors went into the business.

"The benefit of applying scientific methods obtainable was demonstrated to the advantage of everybody by W. S. Brownell, a a young graduate of Cornell, whose berries and arrangement of packages were wonderful and obtained prices that were never attained before the year 1900. His invasion of the Syracuse market was a great success, although plenty of berries of the common variety are grown in that vicinity.

"The outlook for the season of 1901 is very bright. The financial condition of the country is excellent. The Pan-American Exposition only five hours away from our fields by N. Y. Central R. R., will require an immense amount of strawberries; and the Oswego growers should see that the show of berries is good."

G. W. Baker's account of the beginning of the industry.—"I find by my books that the first strawberry train was started by Mr. A. A. Bush in 1873. The first berries in this town were set by Mr. Rensselaer Richards, of Oswego Centre, about the year 1853. The plants were furnished by a nurseryman of Rochester, Wright by name. Mr. Wright was to have one-half the crop as payment for the plants. The principal kind was called Black Prince. Other early growers were H. P. Fitch, A. S. Jenne, Seymour Coe, Henry Rowe. Later on William Adams, William Stark, J. G. Warren and many others engaged in the business. The Baker crate was the first crate introduced in Oswego County, and is still in use. In the early stage of the berry-growing the fruit was taken to market in pails or baskets and found a ready sale at twenty-five cents per quart. The first crate held forty-five two-quart boxes, nailed at the corners like a small packing box. The boxes cost five cents each. The

Baker crate in its present form was invented by Baker Brothers in 1872, and cost in that year $2.25 each. At present the same package (36 quarts) sells for seventy-five cents."

Statistics of the Oswego strawberry business.—It is impossible to secure complete statistics of the volume of business done in strawberries in the Oswego district. The best that can be done is to print the records of the express and freight shipments by rail, which shipments may be assumed to represent four-fifths of the commercial crop. The strawberry growing of Oswego County probably covers 1,000 acres. The average net f. o. b. price realized for berries ranges from 6 to 8 cents per quart. All berries are shipped in 36-quart crates. Geo. A. Davis, Mexico, one of the leading growers, writes: "From observation I judge that ninety per cent stay in the business, only ten per cent changing yearly. I think, on the whole, that the berry business compares favorable with other branches of farming."

EXPRESS SHIPMENTS OF BERRIES FROM OSWEGO CO. STATIONS IN 1896.

	Number crates.		Weight. Lbs.
	To Boston.	To New York.	
Central Square	.....	592	28,860
Daysville.	.....	24	1,440
Fulton	4	978	8,580
Homesville	57	290	21,100
Mexico	263	3,624	232,020
New Haven	174	2,951	187,500
North Scriba	35	2,807	180,520
Pulaski	.....	307	18,420
Richland	.....	16	849
Sandy Creek	1	85	5,160
Union Square	.....	86	5,160
Total 1896	534	11,760	689,609
Total 1895	756	10,335	665,460
Increase	.....	1,425	24,149
Decrease	222		

Number of cars 1895	68
Number of cars 1896	**115**

FREIGHT SHIPMENTS HAVE BEEN AS FOLLOWS FOR A SERIES OF YEARS.

	1894. Crates.	1895. Crates.	1896. Crates.	1897. Crates.	1898. Crates.
Oswego station	2,800	1,770	1,880	6,875	8,750
Fulton station	872	None	None	None	None

STRAWBERRY BUSINESS IN 1898 AS SHOWN BY THE ICE CAR SERVICE OF THE AMERICAN EXPRESS CO.

STATION.	Number crates.		Total number crates.
	To Boston.	To New York.	
Adams	18	4	22
Camden	108	154	262
Central Square	14	64	78
Daysville	57	98	155
Fulton	295	990	1,285
Hastings	2	3	5
Mexico	1,693	2,920	4,613
New Haven	1,412	3,900	5,312
North Scriba	1,699	4,603	6,302
Parish	29	130	159
Phœnix	.....	63	63
Pulaski	110	421	531
Richmond	2	32	34
Sandy Creek	74	764	838
Union Square	84	134	218
Oswego	4,362	4,647	7,009
			26,886

The American Express Co. shipped without icing, in 1898, about 5,377 crates. The Lehigh and other carriers handled about 20,000 crates. This makes a total of 1898 of 52,263 crates, or nearly two million quarts.

COMPARATIVE STATEMENT OF STRAWBERRY BUSINESS IN 1899 AND 1900.

	To Boston.		To New York.		To Philadelphia.	Local.
	1899. Number crates 36 qts.	1900.	1899.	1900.	1900.	1900.
Eastern New York Division Ice Cars American Express	4,604	5,614	16,364	7,670		
Western New York Division Ice Cars American Express						
To Webster, east, including Oswego	4,500	5,500	13,500	12,000		
Shipments to Philadelphia	......	......	......	......	3,500	
Shipments to local trade	......	......	......	......	......	6,000
	9,104	11,114	29,864	19,670	3,500	6,000

Total 1900, 40,284 crates, 1,550,224 quarts.

It is probable that the total crop of the Oswego district in 1900 was nearly two million quarts.

Bulletin 190. A 2. May, 1901.
Cornell University Agricultural Experiment Station,
ITHACA, N. Y.
ENTOMOLOGICAL DIVISION.

THREE UNUSUAL STRAWBERRY PESTS

AND

A GREENHOUSE PEST.

(*From Webster.*)

By M. V. SLINGERLAND.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.
1901

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Of the Cornell University Agl. Exp. Sta.

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The regular bulletins of the Station are sent free to persons in the State who request them.

Cornell University, *May* 3, 1901.

Honorable Commissioner of Agriculture, Albany:

Sir.— This bulletin embodies the results of observations made last year on four serious insect pests, three of them attacking strawberries and the fourth working in greenhouses. Two of the strawberry pests gained a place in the rogues' gallery of injurious insects some years ago, but they have never before been injurious in New York. The other insect discussed as a strawberry pest has heretofore borne a good reputation as a beneficial insect, hence we were much surprised to find it capable of ruining a $350 crop of fruit in two or three days.

Two or three years ago the horticultural greenhouse became infested with an insect which has been the most annoying pest that ever infested the plants. A careful study of its life and habits, and the results of the various methods used to control it are herein recorded.

The camera has enabled the author to graphically and accurately illustrate the different stages of all these insects and their work.

This report is submitted for publication as a bulletin under Chapter 430 of the Laws of 1899.

I. P. ROBERTS,
Director.

THE OBSOLETE-BANDED STRAWBERRY LEAF-ROLLER.

Cacœcia obsoletana Walk.*

Order LEPIDOPTERA ; family TORTRICIDAE.

About June 1st, 1900, we were informed by a telegram that an insect was seriously damaging the leaves and young fruit of a strawberry patch in Westfield, N. Y. We saw the injured plants a few days later, and found the depredator to be one of the leaf-rolling caterpillars. About half of a field of one-fourth of an acre of strawberries had been seriously injured, and from one-half to two-thirds of the crop ruined by the insect. Later it was learned that a neighbor's strawberries had also suffered from the same pest. Although specimens of the insect were captured in New York over thirty years ago, it has never before been reported as occurring here in injurious numbers. Hence it is a new strawberry pest in New York, but thus far only Westfield growers have complained of its ravages. It had, however, gained a place in the rogues' gallery of injurious insects in 1883, when it was abundant in some strawberry fields in Illinois. We have succeeded in learning much of the life-story of the insect, and our camera has enabled us to fully illustrate all stages of its life and its work, mostly from life.

Its work.— The pictures shown in figure 35 well illustrate the work of this leaf-rolling caterpillar. At *b* the caterpillar is performing the interesting operation of rolling the leaf by spinning silken threads above its body from one side to the other across the midrib and thus gradually drawing the edges of the leaf together; at *a* is shown two leaves just rolled. Within this protecting roll

* For synonomy see Trans. Am. Ent. Soc. X., 12 and foot-note; see Forbes' 2d Ill. Rept. (1883), p. 95–6, for all that has been written of the insect's habits and life.

the caterpillar lives, feeding upon the leaf and often joining other leaves to it; some badly eaten leaves are shown at *d* in figure 35. Sometimes the caterpillar forms a similar protection by drawing together the blossoms and forming fruits which it eats, as shown at *c* in figure 35; fortunately the caterpillars work mostly on the leaves.

Its life-story.—When we saw the insect's work on June 5th, most of the caterpillars were then from one-half to full grown, and we saw no other stage of the insect in the field. A full-grown caterpillar is well illustrated in figure 36. It is of an olive-green color with a light brown head and thoracic shield, both marked with black; the body is sparsely clothed with light-colored hairs arising from pale, roughened tubercles, as is well shown in the figure.* The caterpillars are active creatures, quickly wriggling out of their leafy home when touched.

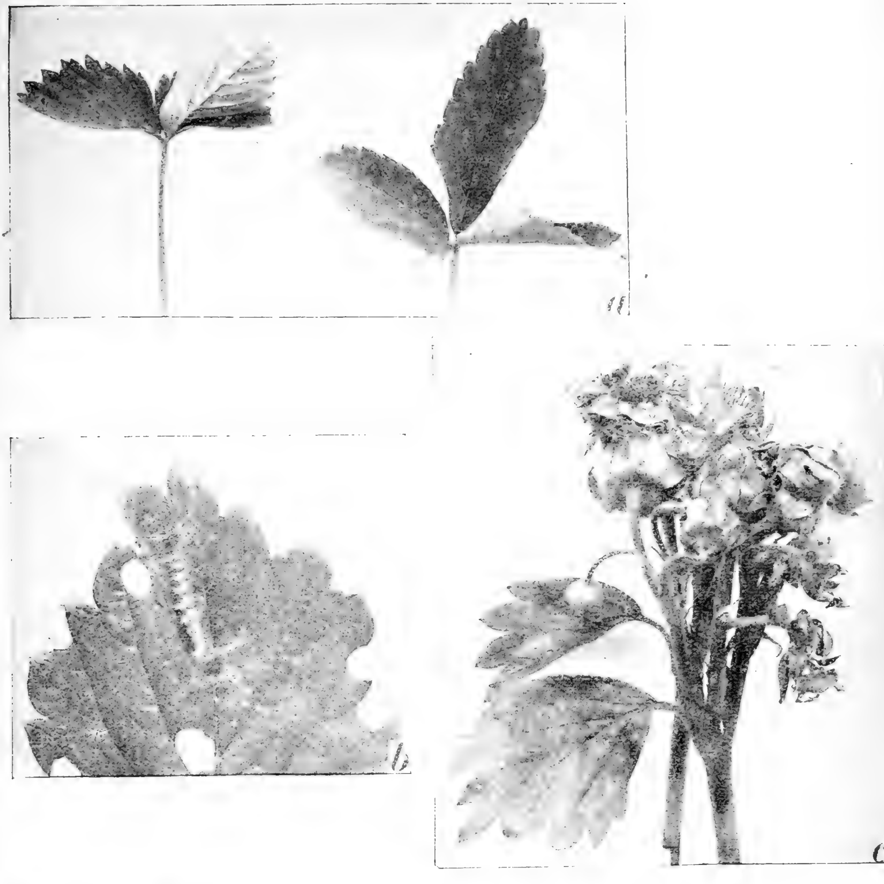
We brought many of this spring brood of caterpillars to the insectary and bred the insect through the rest of the season in our cages.

By June 6th several of the caterpillars had transformed in their leafy homes to *pupæ*, that quiescent stage in their lives when they are made over into the adult insect. The general characteristics of the pupa are well shown in figure 37. They are from 13 to 15 millimeters (little more than half an inch) in length and of a dark brown color, darker on the dorsum.† This pupa stage lasted about ten days in June, so that by June 15th we found that some of the adult insects had emerged, and others continued to appear in our cages until July 5th.

The characteristic form, size and markings of the pretty little brown moths or adults are well brought out in figures 39 and 40.

* The five pairs of prolegs are concolorous with the body, while the true legs are blackish. The posterior border of the head is marked with four v-shaped blackish spots, and the thoracic shield is marked with a blackish border, sometimes so wide as to nearly cover the shield.

† The pupa is sparsely hairy, mostly on the venter of the abdomen. Two rows of short, spiny teeth cross the dorsum of the abdominal segments, as shown on side view of pupa in figure 37. The tip of the abdomen bears four slender hooked or curved spines, and on each side not very near the tip are two more similar, curved spines or hooklets.



35.— *Work of the obsolete-banded strawberry leaf-roller.* b, *a leaf being rolled by the caterpillar*
a, *leaves just rolled ;* c, *young fruits are sometimes tied together and ruined by the cater-*
pillars ; d, *how the caterpillars destroy the leaves which they roll. All natural size.*

Their general color varies from a wood-brown through cinnamon to russet; the hind wings and all four wings beneath are of a lighter yellowish-brown color. Many fine, wavy, transverse, dark brown lines occur on the front wings, showing more distinctly in the male. And extending obliquely across these wings is a broad, dark brown band, more or less obsolete in the middle, and there is a sub-apical spot of the same color on each front wing. Many purplish scales often occur in these dark bands. The front wings of the female moth are not so distinctly marked as in the male (as shown in figure 40) and sometimes there is a female with darker, russet-brown wings, as shown at *d f* in the same figure.*

We placed several of the moths in cages on strawberry plants and on the night of June 24th eggs were laid, not on the plants, as one would suppose, but on the smooth, glass sides of the cage. The thin, oval, light lemon-yellow eggs were glued to the glass in clusters of more than a hundred, and they overlapped each other not unlike shingles on a house. The eggs are well shown in figure 38. The shell is finely reticulated, the micropyle showing plainly at one end. This stage of the insect had not been seen before. The fact that the moths never laid their eggs on the plants in our cages, leads us to suspect that in the field they oviposit on smooth substances like stones or perhaps more likely upon the stems of straw or other materials used for a mulch. The egg stage lasted ten days, hatching on July 6th.

The newly-hatched caterpillars were light yellow in color with a brown head, and they readily found their way onto the plants where they fed mostly on the under sides of the leaves, skeletonizing small

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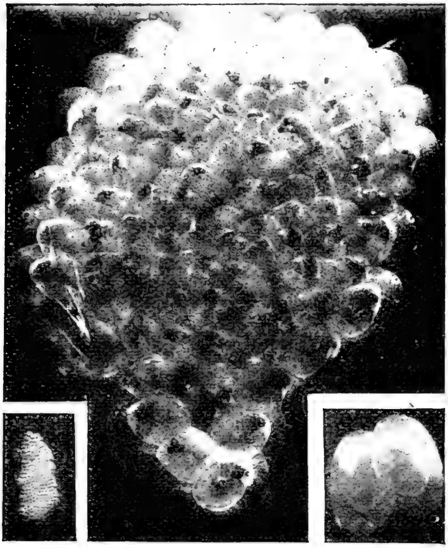
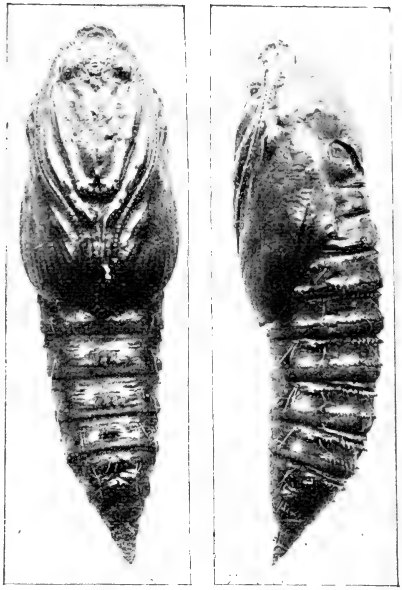
* The two sexes were first described as distinct species (the male as *obsoletana*, and the female as *transiturana* in 1863). They were again so described under different names in 1865 and 1869, but in 1862, Fernald suspected they were but sexual forms of one species, and in 1883, Forbes first demonstrated this by breeding experiments. For references, see foot-note, p. 159. The insect is known to occur in Massachusetts, New York, Pennsylvania, Virginia, Florida, Texas, Illinois, and Montana, and is thus widely distributed in the United States.

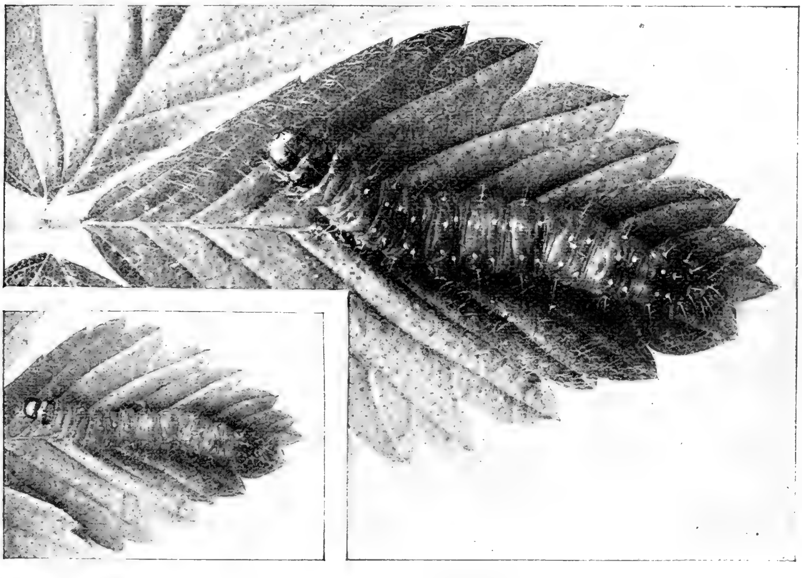
Forbes called the insect the "Plain Strawberry Leaf-roller," but we prefer to connect the popular name more closely with the scientific name, suggestive of the obsolete portion of the dark band across the wings, thus: *Cacœcia obsoletana*, the Obsolete-banded Strawberry Leaf-roller.



38.— *Eggs of obsolete-banded strawberry leaf-roller; egg-cluster much enlarged, with another cluster natural size in lower left-hand corner; two eggs much enlarged in lower right-hand corner. Young larvæ can be indistinctly seen in the eggs of enlarged cluster.*



37.— *Pupa of obsolete-banded strawberry leaf-roller; ventral and side views, much enlarged. Their natural size is a little more than half an inch in length.*



36.— *Caterpillar or larva of obsolete-banded strawberry leaf-roller; natural size in lower corner and twice natural size above.*

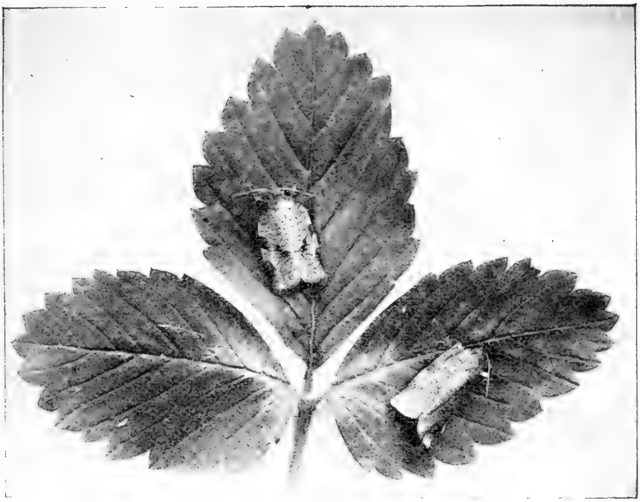
areas; they first lived in a little tube formed by tieing the leaf-hairs together with silk near a vein or between two veins. In a few days they began to roll the leaves.

By the middle of August many of the caterpillars of this second brood had gotten their growth in our cages; they would have doubtless grown faster in the field, for we did not keep them fully supplied with fresh food. Some pupated on August 16th, and the moths emerged nine days later. We soon obtained eggs and had another brood of caterpillars feeding in September.

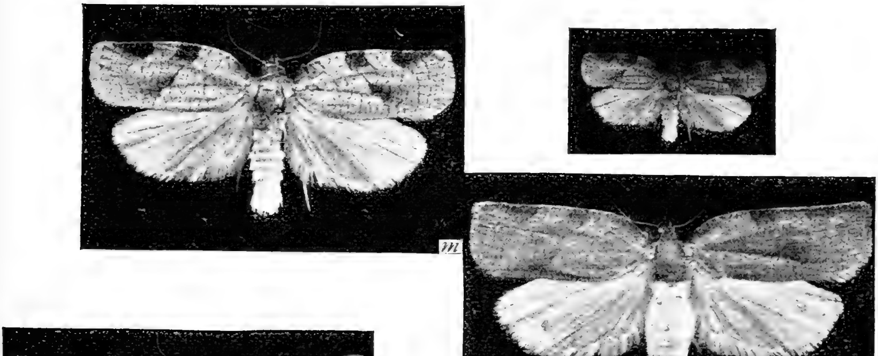
Thus, there may be three broods of the caterpillars developed on the plants during the growing season, in May, in July, and in September; this fact makes it a much more serious and destructive pest. We have not ascertained in what stage the insect passes the winter, but probably not as a caterpillar; some of its near relatives hibernate in the egg stage, others as moths or pupæ.

Its enemies.— No natural enemies have heretofore been recorded as attacking this strawberry leaf-roller. Among some of the caterpillars sent us from Westfield on June 1st was one dead specimen surrounded by several small maggots feasting on its body; we were not able to determine if they were internal or external parasites. Three days later the maggots had spun their cocoons near their dead host. And on the 12th and 15th of June six small, Braconid, parasitic flies emerged; their bodies and legs were of a light brown color, with the head black. Mr. Ashmead determined them as his *Rhyssalus atriceps* Ash. (Proc. U. S. Nat. Mus., 1888, p. 628), which parasitizes the oblique-banded leaf-roller of the apple. (*Cacœcia rosaceana*).

Remedial measures.— This strawberry leaf-roller is destructive only in its caterpillar stage, when it lives most of the time well protected in its rolled, leafy home. One infested patch at Westfield was sprayed about June 1st with Paris green (using 1 pound in 150 gallons, without lime). The leaves and forming fruits were badly injured by the spray and we could find but few dead caterpillars a few days later. Swift's arsenate of lead or Bowker's Disparene would not injure the foliage. It is not advisable to spray the plants between the time of opening of the blossoms and the picking of the fruit. If the patch is known to be infested, a poisonous



39.—*Male (above) and female (below) moths of obsolete-banded strawberry leaf-roller, at rest, natural size.*



40.— *Moths of obsolete-banded strawberry leaf-roller.* m, *male;* f, *female;* d f, *dark variety of female. All twice natural size except the male moth in upper right-hand corner.*

application just before the blossoms open in the spring might be desirable and profitable. Usually, however, the pest will not be discovered until later, and the spraying should then be delayed until after the fruit is picked. We believe that one or two thorough applications of a poison in July or early September would greatly reduce the numbers of the caterpillars and thus prove profitable; we would spray with the arsenate of lead or a carefully made arsenite of lime or soda. (See Spray Calendar, Bulletin 188, for formula.)

Probably the most effective method of combatting this pest will be to mow the infested strawberry patch soon after the fruit is picked. Allow the mown leaves to dry a few days, then burn over the patch, using a little of the mulching or dry straw if necessary to make it burn well. This fire will destroy the caterpillars and pupæ which happen to be on the leaves, and rarely will it injure the plants in the least. This is a cheap, practicable method and has been found to be very effective against other strawberry leaf-rollers. It must be remembered, however, that this burning over process cannot help the crop for that year, but it will greatly reduce the horde of caterpillars which might otherwise develop to ruin the crop the next year.

The ploughing under of infested plants would, of course, effectually check the pest; it is often best to treat old strawberry beds in this way.

GROUND-BEETLES EATING STRAWBERRIES.

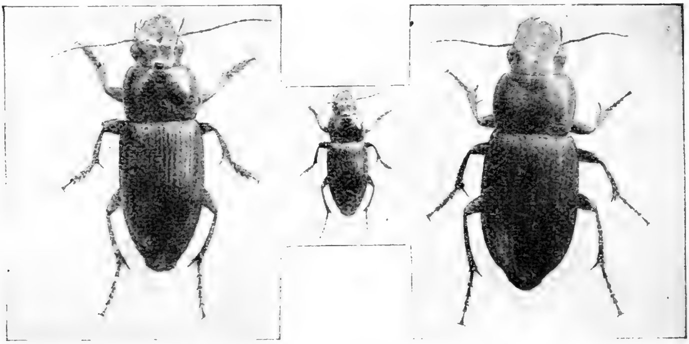
Harpalus caliginosus and *pennsylvanicus.*

On June 25th, 1900, a correspondent at Leechburg, Pa., wrote: "We are sending you sample of bugs that have almost ruined our strawberry crop this season. They are under the straw mulch, thousands of them, and they attack the berries when they begin to color, eating the seeds and a part of the surface of the fruits." More of the insects were sent us on July 3d and 9th, and we glean the following interesting facts from the letters accompanying the specimens: "We caught the beetles right on the berries feeding. They eat the berries only at night, beginning about 8:30 or 9 o'clock P. M. We had to take a light to watch them working. Since writing you on June 25th the beetles have become more destructive, completely taking one-fourth of an acre of late strawberries in three nights! * * * We estimate our damage at $350. The beetles would start on the very largest berries and at last would eat green berries too; they completely destroyed everything on the plants. Our soil is a clay loam with no stones near the strawberry patch, which contains two acres. We find from 6 to 10 beetles around each hill of berries. The bed was a clover sod planted in early potatoes in spring of 1899, and then planted in strawberries the following July and August; a straw mulch about two inches thick was put on in December. On one side of the bed are black raspberries and on the other side vegetables are growing. At first the beetles ate only the surface of the berries, but they now know they have found something good and eat the whole berry. They always go in pairs."

The insects thus accused of eating strawberries were the two kinds of very common large black ground-beetles shown in figures 41 and 42; most of the damage was done by the larger kind, but few of the smaller ones being found. As these beetles had heretofore borne a good reputation as predaceous enemies of other

and oftentimes injurious insects, we hesitated to believe that they could be the culprits. But we were soon convinced of their guilt when we placed some of them in a cage with ripe strawberries. In less than an hour we saw them at their nefarious work, and in 24 hours, 12 of the beetles had made about 20 large berries look like those in figure 43.

A microscopic examination of the alimentary canal in a large number of ground-beetles (12th Rept. State Entomologist of Illinois, pp. 105–116) has shown that a considerable percentage of their food may be of a vegetable nature, but that in most cases they showed a partiality for animal food where it was easily obtainable. The two kinds of these beetles found eating strawberries are known to some-

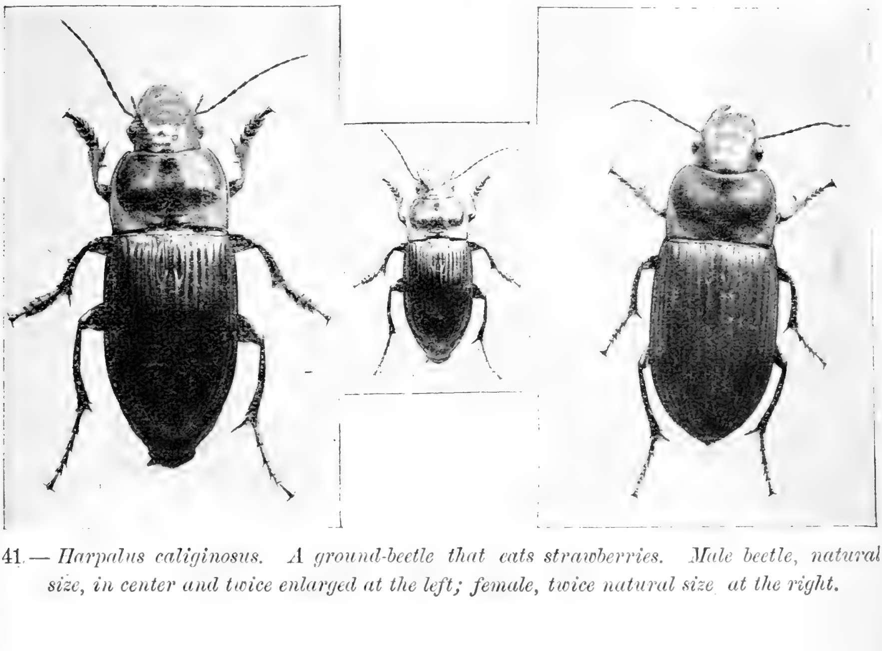


42.—*Harpalus pennsylvanicus. Male beetle natural size in center and twice enlarged at the left; female, twice natural size, at the right.*

times include young grasshoppers and various kinds of injurious caterpillars in their daily diet. In their grub stages they are also said to be carnivorous, but there is little definite knowledge recorded of their life-histories. Both kinds of the beetles, however, have several times been found feeding on the seeds of the common rag-weed (Can. Ent. xxxii., 270) and on the seeds of grasses. Hence it is not so surprising after all to find them enjoying a diet of straw-berry seeds, sometimes also flavoring it with the luscious pulp of the fruit.

It was our first experience with these ground-beetles in an injurious rôle, and we failed to find any record of such bad habits in American entomological literature. But we soon learned that

43.—*Strawberries showing the destructive work of ground-beetles; at the extreme right is an uninjured fruit. Natural size.*



41.—*Harpalus caliginosus. A ground-beetle that eats strawberries. Male beetle, natural size, in center and twice enlarged at the left; female, twice natural size at the right.*

entomologist Webster had just investigated a similar outbreak in June in Ohio (Proc. Ass. Ec. Ent. Bull. 26, U. S. Div. Ent. pp. 88–89; Can. Ent., xxxii., 265–271). He found that the injury was done between 8 P. M. and 7:30 A. M.; the injured fruit was but little eaten, but nearly every seed was missing and the hulls scattered underneath (see figure 44). The damage proved very severe, several strawberry growers reporting that half their crop had been ruined in 1900; nine-tenths of one crop was ruined within 48 hours, and one man did not pick 5 per cent of his Crescents and of ten other varieties none were picked. Some other growers had lost a large portion of their crop from similar depredations in 1898 and 1899, but the real culprit was not then discovered. Similar serious injury to ripe strawberries by a closely allied beetle (*Harpalus ruficornis*) was observed in Holland in 1892 (Biol. Centralb., xiii., p. 255), and during the years 1894, 1895, 1897–99 in England (see Miss Ormerod's reports for these years).

44.—*Work of ground-beetles on a strawberry. Note the hulls of the seeds scattered on the leaf below the fruit. (From Webster.)*

The beetles evidently attack the fruits primarily to get the seeds, and considerable of the pulp adheres to the seeds when they are removed; but sometimes the beetles eat much of the pulp also. Ripening berries which they have fed upon often soon begin to rot, and they ruin for any purpose every berry they attack. See figure 43.

The favorite haunts of the beetles are under stones and rubbish on the ground, hence the usual mulch on a strawberry bed forms an

ideal lurking place for them. Perhaps when we know more about their lives and breeding habits, we can better understand their occurrence in strawberry patches in such astonishing numbers. In Ohio the beetles have been destructive in the same fields for three successive seasons.

Remedial measures.— The evidence of those who have suffered from the depredations of these ground-bettles is conclusive that they are capable of ruining a whole strawberry crop in a few days. Hence, some swift and inexpensive method of checking their ravages is wanted. Unfortunately, from lack of experimental evidence, our recommendations must be largely suggestive.

If the mulch were raked off, one could doubtless entice many of the beetles to hide during the day under boards, chips, etc., placed near the plants, where they might be readily collected by hand and killed. It is reported that in Ohio the burning over of the patches was not effective. They probably can not be effectually reached with a spray of poison, soap or oil. Keep the strawberry patch and near-by fields as free as possible from ragweed, whose seeds are favorite food for the beetles; this would doubtless materially help in the warfare. It is doubtful if any substance could be applied to the soil in sufficient quantities to kill the beetles and not injure the vines. The beetles are attracted to lights in large numbers, especially to electric or other brilliant lights. It is thus possible that a bright oil light from a good lantern fastened on a brick in a pan set on top of a post might attract the beetles in paying quantities; fill the pan about two-thirds full of water and pour a liberal film of kerosene oil over the water to kill the beetles as they get into the water. We believe this trap-lantern is worthy of a trial by afflicted strawberry growers, but it may work in theory only. Possibly the beetles would eat poisoned wheat bran placed under boards in the evening, as Webster suggests.

In England Miss Ormerod has shown (Rept. for 1897, p. 113) that even when feeding on strawberries the beetles do not lose their carnivorous appetites, and may be attracted by meat. Some English strawberry growers report that they " almost entirely destroyed the beetle pest" by sinking into the ground to the level of the surface a lot of cheap basins or dishes and then keeping these traps baited

with pieces of meat ("lights") and sugar water; in dry weather they often caught half a basinful in a night! Another grower caught enormous numbers of the beetles by pouring about half an inch of tar in the bottom of the basin traps. Doubtless any kinds of spare waste meat or fish would prove equally attractive to the beetles, and some cover such meat with thick sacking and then collect by hand those which gather around and under this bait. These trapping methods involve considerable trouble and expense, but one had better spend $25 in thus protecting a $250 crop of strawberries which the beetles are capable of ruining in a few days.

A sure, practicable, although laborious method is to "hand-pick" or collect the beetles from their hiding places during the day under lumps of dirt or just beneath the surface of the soil near the base of the plants. The removal of the mulch would facilitate this in many cases. Children could readily be induced to collect the beetles for a small sum per 100. For studying the general structure of an insect, the larger kind of these ground-beetles (figure 41) are excellent aids in a laboratory. For this purpose the Entomological Laboratory of Cornell University paid one cent each for 1,700 of the beetles, which boys easily collected in the strawberry patch of our Leechburg, Pa., correspondent, and the crop of beetles must have been materially reduced thereby. We believe that $35 paid to children for collecting would have saved most of the $350 worth of fruit which the beetles got at Leechburg.

A STRAWBERRY "WHITE-FLY" OR "MEALY-WING."

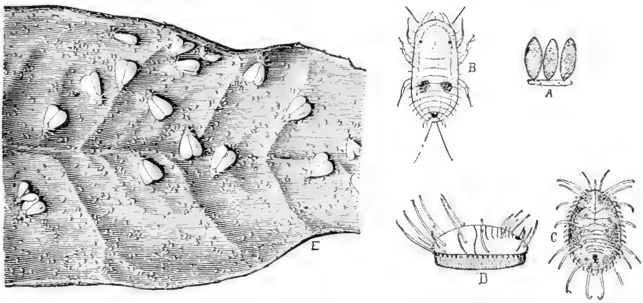
Aleyrodes sp.

In the fall of 1897 and again in July, 1900, we received specimens of strawberry leaves which were seriously infested with a peculiar scale-like insect; the first specimens came from Sparkill, Rockland Co., N. Y., and those last year from Rossville, Staten Island, or not far from the first. The following statements from letters of our correspondents well describe the insects' work:

"Our strawberry plants are full of very small white flies. They seem to suck the sap out of the leaves; they are on the under sides of the leaves, and when disturbed fly away. The leaves turn black on the outer edges where they are infested badly and some plants are nearly or quite killed by them. Certain varieties are more infested than others.

"The leaves I enclose were taken from plants set this spring which have been attacked by small white insects on the under sides of the leaves," writes our Rossville correspondent in July, 1900. "When I touched the plants, the flies, not larger than a grain of salt, but perfectly white, would rise up by the thousands in clouds. The plants started off very vigorously with large healthy runners. Finally, I noticed that the plants began to look dead, leaves began to die and the runners began to wilt and dry up. Some of the plants are dead. The patches that were in bearing were also found to be badly infested later in the season. While picking the fruit, the upper sides of the leaves seemed glossy like varnish, and the pickers remarked that their hands were covered with a stickiness. Later on the plants had a black, smutty appearance. These plants were very vigorous but now the greater part of them have turned brown and died out entirely."

The depredators proved to be members of a peculiar family of insects known as the *Aleyrodes*, or popularly as "white-flies" or "mealy-wings;" * these apt names were suggested by the fact that the adult insects have their four wings covered or dusted with a white, meal-like secretion of wax. Some of these minute "white-flies" are shown about twice natural size at E in figure 45, and one is shown much enlarged with wings spread at *e* in figure 46. At A, figure 45, and *b*, *c*, figure 46, are shown some of the peculiar stalked eggs which are attached to the under sides of the leaves, from which hatch in about ten days the active louse-like nymphs shown at B, figure 45, and *d*, figure 46. These nymphs soon settle down and



45.—*A common greenhouse Aleyrodes. A, eggs; B, young nymph or "larva;" C, D, dorsal and side views of full-grown nymph or "pupa" (A, B, C, D, much enlarged). E, adult Aleyrodes or "white-flies" and their eggs on orange leaves, about twice natural size. (Reduced from Davis.)*

begin to suck out the sap of the plant, gradually increasing in size and finally in two or three weeks attaining the advanced nymph or

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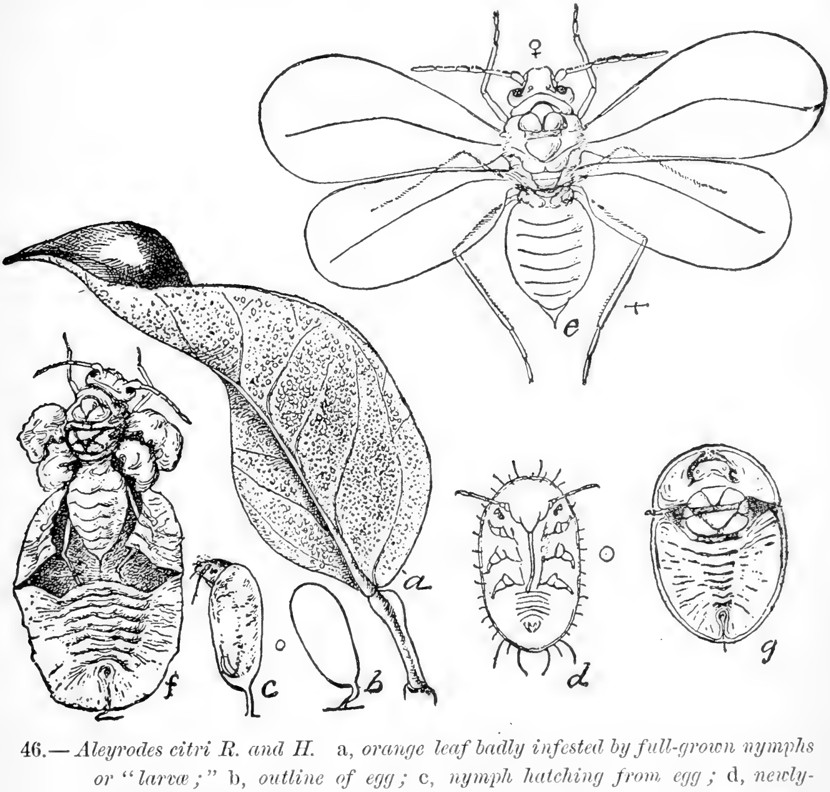
* We sent some of the infested leaves to Professor Quaintance and he reported that the species was much like *Aleyrodes vaporariorum*, but he could not be sure as to the species owing to the rather broken up condition of the specimens and the absence of adults. The above species is the one commonly found in greenhouses on various plants. It was described in 1856 by Westwood (Gard. Chron., p. 852), and it is interesting to note that he says it is "supposed to have been imported into England with living plants or in the packings of *Orchidaceæ* from Mexico." Our American Aleyrodids have been recently monographed by Professor Quaintance (Bull. 8, Tech. Ser., U. S. Div. Entomology). Some modern writers use the form *Aleurodes*, but we have followed the original spelling of the word, *Aleyrodes*, as given by Latreille.

so-called "pupa" stage when they greatly resemble scale insects, as shown at C and D, figure 45, and *g*, figure 46. In a few days the skin splits open and the minute, four-winged adult emerges, as shown at *f* in figure 46. Thus the whole life cycle may be passed through in four or five weeks, so that three or more broods of these "white-flies" may work on the strawberries during the growing season. The strawberry leaves sent us were nearly covered on the



46.—*Aleyrodes citri R. and H.* a, *orange leaf badly infested by full-grown nymphs or "larvæ;"* b, *outline of egg;* c, *nymph hatching from egg;* d, *newly-hatched nymph, ventral view;* e, *adult female insect;* f, *adult with wings still unfolded emerging from nymph or "pupa" skin;* g, *advanced nymph or "pupa." All much enlarged except* a. (*After Riley and Howard.*)

under side with the scale-like nymphs of these interesting creatures, which are very closely related to the scale-insects and the plant-lice. Most, if not all, of the injury is done by the nymphs, which suck their liquid food or sap from the interior of the plant. They work

on the under sides of the leaves and, like plant-lice, secrete large quantities of the sticky, sweet liquid called "honey-dew;" in this honey-dew a black, sooty mold often grows, and thus gives the leaves a black, smutty appearance.

We have found but few records* of "white-flies" attacking strawberries and none indicate as serious injury as our correspondents report in southeastern New York.

Remedial measures.—It will not be an easy matter to control these "white-flies" in strawberry patches or fields, for they are sucking insects, hence must be hit with a spray, and they also work entirely on the under sides of the leaves where it will be difficult to hit them. A spray of kerosene emulsion, kero-water (10 per cent kerosene), or whale-oil soap (1 pound dissolved in 5 gallons water) will doubtless kill all of the nymphs or adults which it hits; probably the eggs would not succumb to such a spray, hence several applications at intervals of 10 days would be necessary. Use an underspray nozzle (nozzle on tube bent at a right angle) so as to direct the spray onto the under sides of the leaves. Young plants taken from infested beds or those showing any indications of being infested with these "white-flies" should be thoroughly fumigated with carbon bisulphide or hydrocyanic acid gas before setting them.

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* 1889. Packard. Guide to Insects, 712. Found on strawberry at Amherst, Mass.

1891. Gorman. Agr. Science, V., 264. Same account in An. Rept. Ky. Expt. Sta. for 1890, p. 37–38. Numerous on strawberry at Lexington, Ky.

1892. Riley. Insect Life, V., 17. Found on strawberry in Dist. of Columbia.

1893. Webster. An. Rept. Ohio Expt. Sta., p. xxxv. Very numerous on strawberry, but no serious injury resulted.

THE GREENHOUSE LEAF-TYER.*

Phlyctaenia rubigalis Gueneé.†

Order LEPIDOPTERA; family PYRAUSTIDÆ.

During the summer of 1898 this insect was first noticed in the greenhouses of the Horticultural Division of this Station, and ever since, both summer and winter, it has been the most troublesome and annoying pest that ever infested the houses. It is apparently an old offender in greenhouses, for it was reported as very destructive on Long Island as early as 1888, and then Riley stated that it "had long been known to feed upon various greenhouse plants" (Insect Life, II., 277). Nine years later Johnson found the insect doing much injury to young tobacco plants in a hot bed in Maryland. In 1898 Smith recorded it as eating carnation cuttings in New Jersey (An. Rept. Exp. Sta. for 1898, p. 391), and the next year Galloway treats it as a violet pest (Commercial Violet Culture, p. 214–15). In 1899 it also did much damage to roses in a Canadian greenhouse (Fletcher's Rept. for 1899, p. 179–180), while Dr. Howard wrote in January, 1900, that he "had received quite a number of complaints in regard to its injuries in greenhouses throughout the country." He also states that the insect is "widely distributed from Canada to Florida and from the Atlantic to the Pacific."

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* This discussion is partly an abstract of a thesis by Franklin Sherman, Jr., presented to the Faculty of the College of Agriculture of Cornell University for the degree of B. S. A. in 1900. All of the illustrations are our own.

† Scientists differ regarding the name of this insect. Fernald considers it the same as the European *ferrugalis*, but Hampson has recently (Proc. Zoöl. Soc. London, 1899, p. 242) concluded that our American insect is a distinct species, as first described by Gueneé in 1854, with Lederer's *oblunalis* (1863) and Grote's *harveyana* (1877) as synonyms A few specimens of the European *ferrugalis* from Spain which we have seen are more ferruginous in color than our American form, but our larvæ agree quite closely in all stages with Buckler's descriptions (Ent. Mo. Mag. 1878, vol. xiv., p. 200–204) of *ferrugalis* larvæ.

The insect has not limited its injuries to greenhouse plants, however, for Davis, who seems to have been the first to breed the insect in this country, found it in 1893 boring in the stems and feeding on the leaves of celery in Michigan. And in 1900 Forbes reported it as feeding on the leaves of sugar beet in Illinois fields.

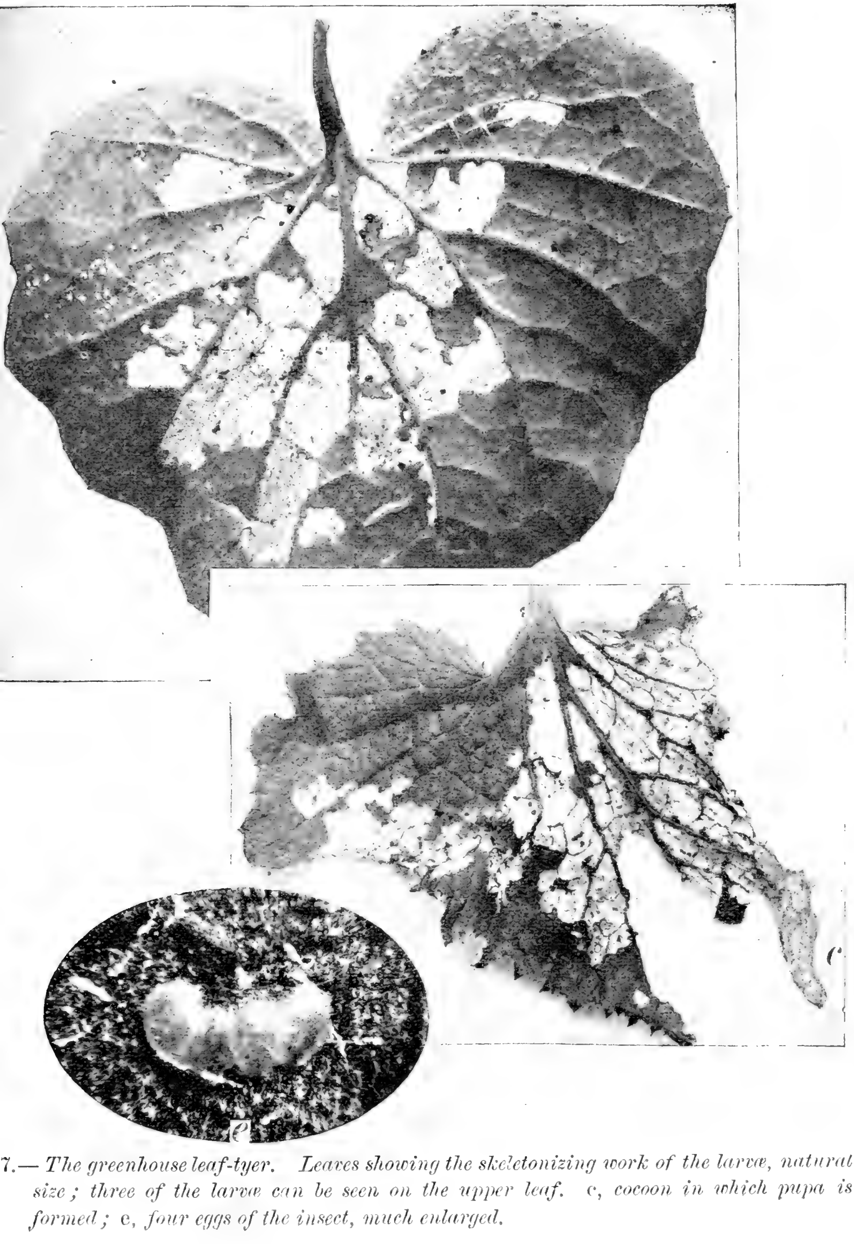
Its food-plants.— In addition to the several plants mentioned above, the insect may include in its menu almost any soft-leaved greenhouse plant. In the horticultural greenhouses here, it has been especially troublesome on lettuce, sweet peas, clover, parsley, cinerarias, chrysanthemums, geraniums, strawberries and cucumbers.

Its work.—The injury wrought by the pest on cinerarias is well shown on the leaves in figure 47. The caterpillars usually work on the under sides of the leaves eating over irregular areas through to, but leaving the upper skin of the leaf. Similar work is done on other thick-leaved plants, like chrysanthemums and geraniums. The thin leaves of lettuce and parsley were eaten entire, while those of sweet peas and clover were skeletonized, as shown in upper part of figure 49.

Often the caterpillars exhibit their rolling or tying habits and two or three small leaves may be loosely tied together with silken threads, or on larger leaves silken bands are stretched across from one large vein to another, often resulting in partially folding or kinking the leaf; the caterpillar works under the silken bands in the fold, as shown in upper right-hand corner of upper leaf in figure 47. But many times there is no tying or rolling of the leaves, the caterpillar feeding openly on the under side under a few silken strands.

Its appearance and life-story.— The adult insect is a small rusty-brown moth with somewhat obscure blackish markings on its front wings; its size and general appearance is well shown in figure 48. In greenhouses the moths may be found resting during the day (see figure 48 for resting position) in angles made by the framework, and also out of sight on the plants. They fly readily when disturbed, but soon alight and rapidly run to the under side of the object on which they alight; when cold, they are less active, and thus more easily captured. They are attracted by lights.

The much flattened, elliptical, translucent eggs of the insect are



7.— *The greenhouse leaf-tyer. Leaves showing the skeletonizing work of the larvæ, natural size; three of the larvæ can be seen on the upper leaf.* c, *cocoon in which pupa is formed;* e, *four eggs of the insect, much enlarged.*

closely attached to the undersides of the leaves in clusters of from eight to twelve, often two to four of which may overlap, as shown at *e* in figure 47. The egg shell is finely reticulated, and is apparently not easily penetrated by liquids as caterpillars were reared from eggs which had been soaked in water for two days. Observations indicate that the egg-stage lasts about twelve days.

The full-grown caterpillar or larva is about three-fourths of an inch long, and of a general translucent greenish-white color; its head is of a dark straw color with darker mottlings, and there is a small, conspicuous black spot in the center of each half of the prothoracic shield. A narrow dark green stripe extends medially along the back, bordered on each side by a much wider, light greenish-white stripe; there are five pairs of pro-legs, the last pair projecting behind when the larva is at rest. The general characteristics of the caterpillars are well shown in figure 49.*

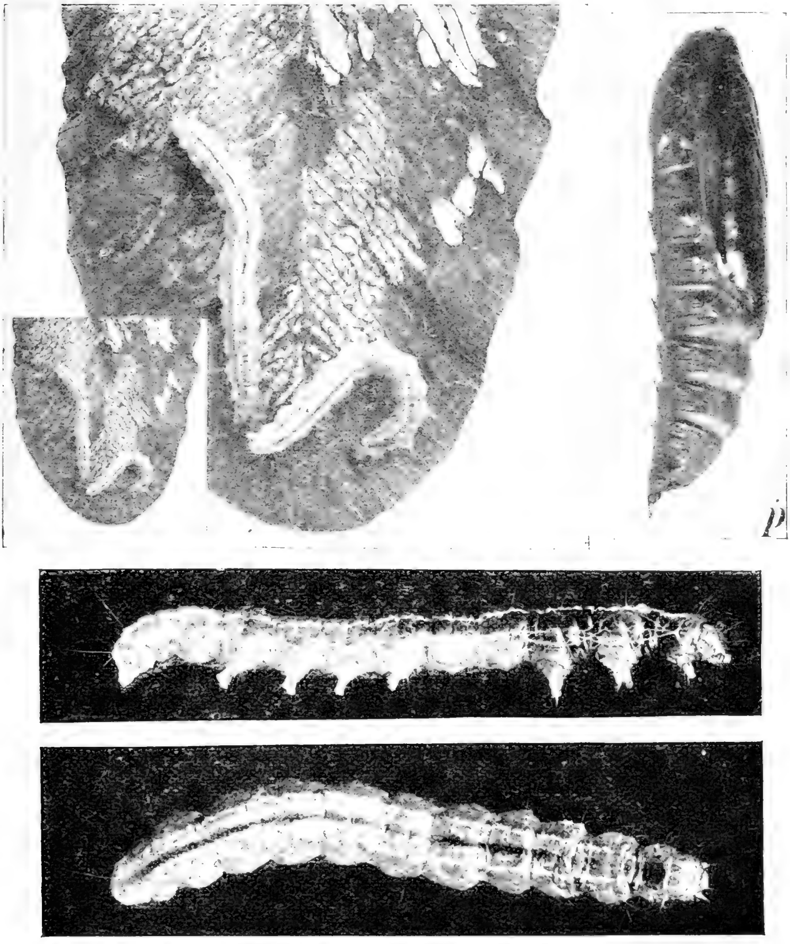
The caterpillars are about twenty days in getting their growth and shed their skins three times or pass through four stages during this period. Usually they move about but little, almost completely devouring one leaf before going to another. When touched, however, they are very active, wriggling quickly backward or forward.

When full grown the caterpillar folds in a lobe of the leaf and fastens it securely with silk, as shown at *c* of lower leaf in figure 47; if the leaf is not lobed, the caterpillar will eat into it to loosen a

* When first hatched, the larvæ are of a creamy-white color, but soon become greenish from the food eaten. The head is blackish and the black theracic spots more or less indistinct. They merely eat small holes through the lower skin of the leaf during this stage which lasts five days. After the first moulting of their skin, the larvæ assume most of the color characteristics of the full-grown larva, but are lighter in general color. They are active, moving freely from place to place on the plant searching for suitable feeding places; they spend four days in this stage. The next or third stage is passed in four days also, and during this time the larva feeds voraciously, increases much in size, and looks much like the mature larva. At the next moult the larvæ enter the fourth and last caterpillar stage when they are also ravenous eaters but move about less than in the third stage. The fourth stage lasts eight days.

Dyar's method of measuring the diameter of the head in each stage was found to work fairly well. The average ratio was found to be 1.516, and the diameters for each stage were .24 to .36 mm.; .45 to .54 mm.; .72 to .78 mm.; 1.01 to 1.17 mm.

48.— *Adult or moth of the greenhouse leaf-tyer. Natural size in center below; twice natural size, at rest (from life), on the left, and with wings spread on the right.*



49.— *The greenhouse leaf-tyer. Caterpillars on skeletonized leaf above (natural s ze in corner of same); side and back views of larva, much enlarged, in lower figures;* p, *pupa, much enlarged.*

piece which it then folds over. In either case the inside of the folded portion is thoroughly lined with silk. In this cocoon, the caterpillar transforms in a day or two into the third stage of the insect's life — the pupa or quiescent stage, shown much enlarged at *p* in figure 49. The pupa is not quite half an inch long (9 to 10 mm.) and is dark brown in color, lighter on the venter.* The pupal stage lasted from twelve to seventeen days. The emergence of the moth (figure 48) then completed the life-cycle of the insect as observed in the greenhouses here.

As the life-cycle may be passed through in from forty-four to fifty days, and as the insect breeds freely during the whole year in greenhouses, seven or eight generations may occur indoors. Forbes' observations (Bull. 60, Ill. Exp. Sta., p. 454) indicate at least four generations annually outdoors. He also states that his observations indicate the hibernation of the insect in the imago or moth stage outdoors in Illinois.

With so many broods in a year, this insect is capable of doing much damage even to outdoor crops. When once thoroughly established in a greenhouse it will ruin thousands of soft-leaved plants unless it is persistently watched and fought.

Remedial measures. — The insect may be readily transported on plants unnoticed in its egg or young caterpillar stages, and it is thought to have been introduced into our horticultural greenhouses on chrysanthemums from an infested locality. Hence one should carefully scrutinize all soft-leaved plants received from other greenhouses; the eggs will usually escape notice, but the work of the caterpillars will soon reveal their whereabouts. Any such plants found infested should be quarantined somewhere until the pest is annihilated. But there is no practicable way of preventing the moths from flying into greenhouses in summer from infested outdoor plants, and the liability of infestation may be as great from this source as from the other.

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* Stiff hairs project from the dorsum of the thorax, as shown at *p* in figure 49, and from a slight tubercle on each side the dorsum of the abdominal segments a less stiff hair projects, curves backward and mesad, often meeting the hair from the opposite side (see *p* in figure 49). Eight curved bristles project close together from the tip of the caudal segment and their curved ends meet and are caught into the silk lining of the cocoon. Four thoracic spiracles show very distinctly.

As the caterpillars feed on the under sides of the leaves, they are not easily poisoned. In the horticultural greenhouses it has been found practicable to spray infested geraniums and chrysanthemums with Paris green, and many caterpillars were killed in this way; such a spray is not often practicable on many of the other plants attacked by the insect.

When a lighted lantern has been carried into the horticultural greenhouses, it has been noticed that some of the moths of this pest were attracted and would flutter about the lantern. A pan of water with a little kerosene oil on its surface was placed in an infested house one night, and a lighted lantern was set on a block in the center of the pan. The weather conditions were such that the moths were not at all active during the night, and but two of them were caught in this trap-lantern. More would doubtless have been caught on a more auspicious night, so that such a trap-lantern is worthy of further trial, and it may materially help to control the pest in some cases.

The infested greenhouses have been frequently and successfully fumigated with tobacco, either as stems, or "rose-leaf extract" for other pests like plant-lice and the "white-fly," but the ravages of the greenhouse leaf-tyer were not checked. Another very expensive tobacco-like insecticide known as "nicoticide" was used with apparent success against the leaf-tyer in a small greenhouse, but when used in commercial quantities in a large house it failed to kill the insect.

In his book on *Commercial Violet Culture* Galloway states that where greenhouses are fumigated with hydrocyanic acid gas for other pests, this leaf-tyer also is easily kept in check. And other reports of the successful use of this deadly gas in killing such greenhouse pests as plant-lice, scale-insects, mealy-bugs and "white-flies" led us to believe that it would be a simple matter to exterminate the leaf-tyer with this gas. But circumstances were such that the gas was only recently tested. A large infested greenhouse (about 8,000 cubic feet space) was fumigated with the gas at the rate of 1 ounce of cyanide to each 400 cubic feet of space for about half an hour; this is about half the strength recommended for other insects. Two live moths of the leaf-tyer in a wire cage were not killed by the gas,

nor were any of the caterpillars or pupæ, but much damage was done to the young growth on roses, carnations and chrysanthemums, and geraniums were considerably injured; perhaps some of the injury to the plants was due to the fact that the fumigation was done in the daylight. Some infested cinerarias were then placed in a tight, dark fumigating box and subjected to the fumes of this deadly gas, using the cyanide at the rate of .15 grams per cubic foot (strongest dose recommended for greenhouses) for half an hour. Result, plants not injured, and even the smallest or one-third grown caterpillars were as lively as ever; some plant-lice, thrips and mealy-bugs, which were also on the plants, were all killed. Half an hour later one of the cinerarias containing the same young caterpillars, some full grown caterpiliars, and a pupa was subjected to the gas at double the above strength (using .3 grams of the cyanide per cubic foot) for half an hour. Result, the small caterpillars only were killed, and the blossoms of the plant were injured; the large caterpillars and pupa were apparently unaffected. We must conclude, then, that our experiments thus far indicate that the greenhouse leaf-tyer will not succumb to the amount of hydrocyanic acid gas which can be generated in a greenhouse with safety to the plants.

Finally, the only method by which they have thus far been able to materially reduce the numbers of the pest in the horticultural greenhouses is by hand-picking or killing. All hands are constantly on the lookout for signs of the insect, and every specimen of moth, caterpillar or pupa found is at once killed. Forty of the moths have been killed in one morning in the houses, and scarcely a day passes that many of the leaf-tyers are not thus sent to their "happy hunting grounds." The moths are quite easily caught or crushed in their resting places, and the caterpillars are readily located by their work on the leaves, and by a constant warfare of this kind the pest can be kept below the danger limit; but, as those who have had experience know, the few remaining stragglers can often annoy the lover of perfect-leaved, symmetrical plants more than a host of plant-lice, mealy-bugs or scale insects.

MARK VERNON SLINGERLAND.

Bulletin 191. A 6. June, 1901.

Cornell University Agricultural Experiment Station,

ITHACA, N. Y.

AGRICULTURAL DIVISION.

TILLAGE EXPERIMENTS WITH POTATOES.

Lessons from the Farmers for the Farmers.

By J. L. STONE.

PUBLISHED BY THE UNIVERSITY,

ITHACA, N. Y.

1901.

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Of the Cornell University Agl. Exp. Sta.

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The regular bulletins of the Station are sent free to all persons residing in New York State who request them.

CORNELL UNIVERSITY, *June* 1, 1901.

HONORABLE COMMISSIONER OF AGRICULTURE, ALBANY:

SIR.—The following bulletin contains a summary of the reports from a considerable number of farmers who have coöperated with the College of Agriculture in cultural experiments with potatoes during the seasons of 1899 and 1900. These experiments were under the supervision of Mr. J. L. Stone. The object sought was not so much to discover new facts or methods, as to demonstrate to the farmers the applicability to their soil and conditions of methods in potato culture that have given excellent results on the College grounds. It has been observed that many farmers are slow to adopt the suggestions of the College and it was thought by locating experiments among them their attention would be better secured and the results obtained would be more impressive than in the case of work done at the College.

This bulletin is submitted for publication under chapter No. 430, Laws of 1899.

I. P. ROBERTS,

Director.

TILLAGE EXPERIMENTS WITH POTATOES.

Summary.— Eighty-five per cent of the reports received from farmers of tillage experiments with potatoes indicate profitable returns resulting from the use of methods recommended by the College, viz.: Early (or twice) plowing, thorough fitting, deep planting; prolonged, frequent, level tillage and spraying with Bordeaux mixture and Paris green.

So much has been written of late years in regard to the importance of manures and commercial fertilizers in agriculture that, possibly, there is danger that farmers may overlook the importance of the physical condition of the soil, tillage and the employment of right methods in treating crops. Experiments conducted on the grounds of this station with potatoes from 1895 up to the present time furnish good illustrations of what may be accomplished by intensive culture without manures or fertilizers. Some of the results of this work have been given in Bulletins 130, 140, 156. With a view to ascertaining if similar results would be secured by similar methods in other localities and more especially for the purpose of furnishing to the farmers in various parts of the State an object lesson in thorough tillage, an effort has been made to arrange coöperative experiments in the tillage of potatoes in various localities. In the spring of 1899 Circular No. 18, "Concerning Coöperative Experiments in Potato Culture," was prepared and sent to a considerable number of farmers who were known to be interested in potato growing. A revised edition of this circular was prepared the following season and as it gives a condensed summary of the results obtained on the Station grounds for five years as well as the plan of the coöperative work, it is here reproduced in full. Furthermore it is desired to keep this line of experimentation before the farmers of the State as it is believed that it will lead to improved methods of potato culture as well as teach valuable lessons in regard to soil management in general.

CIRCULAR

Concerning Co-Operative Experiments in Potato Culture,

No 18.

**Cornell University
Agricultural Experiment Station,
I. P. ROBERTS, Director.**

Revised Edition.

ITHACA, N. Y., *April*, 1900.

Such marked results in potato growing have been secured during recent years on the Cornell Experiment Station grounds, that it has been thought desirable to test the methods employed here to ascertain whether they will give similar results on other soils and in other hands. It is hoped also by having the tests made by the farmers on their own farms, to attract the attention of potato growers to improved methods as it has not been possible to do by the work done at the Station.

The land used for these experiments at the Station is a gravelly soil which analysis has shown is carrying little more than half the potential plant food found in average soils. (See Bulletin 130, p. 157.) It has not been manured or fertilized since the autumn of 1893 (see the same, p. 157) and has produced heavy crops of grain, forage or roots each season till planted to potatoes. (See Bulletin 135, pp. 277, 287.)

In 1895 eight plats averaged at the rate of 352.6 bushels per acre, ranging from 304 to 415 bushels, according to treatment. This season was especially favorable for potatoes and the average for the State was extra high, being 122 bushels per acre. (See Bulletin 140, p. 389.)

In 1896 nine plats averaged at the rate of 352.6 bushels per acre,

ranging from 245.8 to 350.3 bushels, according to treatment. The average yield of potatoes in New York for this year was 89 bushels per acre. (See Bulletin 140, p. 389.)

In 1897 ten plats averaged at the rate of 322 bushels per acre, ranging from 236 to 384 according to treatment. The average in the State for this year was 62 bushels per acre. (See Bulletin 140, p. 390.)

The experiments of 1898 were similar to those of 1897, and are described in Bulletin 156. The average yield of eleven plats was 292.3 bushels per acre, ranging from 206 to 398.6 bushels, according to treatment.

In 1899 eleven plats averaged at the rate of 195 bushels per acre, ranging from 144 to 233. This crop demands a word of comment. The physical condition of the soil now indicates that it is becoming deficient in organic matter and it suffers from drought more than formerly. The thorough preparation and tillage given the plats produced strong vigorous plants in spite of the severe drought of the summer, but an early frost killed the tops before sufficient late rains had fallen to enable the plants to produce the usually large yield, which, however, seemed assured up to the time of this unfortunate event.

For convenience of comparison the above figures are placed in tabular form.

YIELDS OF POTATOES OBTAINED ON C. U. EXPERIMENT STATION PLATS, 1895 TO 1899.

YEAR.	No of plats grown.	Minimum yield per acre. Bush	Maximum yield per acre. Bush.	Average yield per acre. Bush.	Average yield in N. Y. Bush.
1895	8	304	415	352.6	122
1896	9	245.3	350.3	319.4	89
1897	10	243	384	322	62
1898	11	206	398.6	292.3	73
1899	11	144	233	195	88
Average for 5 years	......	228.4	356.2	296.2	87

A comparison of the minimum with the maximum columns brings out clearly the effect of the different methods of treating the

crop *after the plants have come up*, for previous to this time all were treated alike. It will be seen that this amounts to more than 100 bushels per acre. Certainly it is worth while to carefully study the methods of tillage that have produced these results.

The fact of greatest significance, however, is that the yields given in the minimum column are so high. The average of this column, which is made up of the lowest yield obtained from any plat each year, is 228.4 bushels. Remember this is naturally poor land, it has had no manure or fertilizer since the winter of 1893–4, it has produced heavy crops of grain, roots or forage each season since, and it is not of a texture that is supposed to be favorable for potato growing, because it is quickly affected by drought. What, then, is the secret of these high yields when so many of the conditions are unfavorable? No attempt is made to here answer this question *in detail*, but the reader is urged to carefully study Bulletins 130, 140 and 156 for information concerning the growing of these crops.

To briefly answer the above question, it may be said that these high yields were obtained:

1st. By thorough preparation of the land before planting, thereby developing in the soil an abundant supply of readily available plant food and securing the storage of a large amount of water.

2d. By deep planting followed by frequent and prolonged tillage of the crop, thereby preventing waste of moisture by (*a*) evaporation from the surface of the soil, or, (*b*) transpiration from the leaves of weeds, and at the same time bringing more plant food into available condition.

3d. By maintaining healthy and vigorous foliage on the plants throughout the season by spraying with Bordeaux mixture and Paris green. These three counts may be considered as the three legs of a stool, wanting any one of which the stool may easily be toppled over.

CO-OPERATION OF FARMERS DESIRED.

It is desired to secure the coöperation of a considerable number of farmers in the State with a view of testing the methods of potato culture in vogue in their vicinity as compared with the

13

method herein suggested, which is largely based upon experience gained in growing these crops.

The area to be devoted to the experiment is immaterial — the grower setting apart such a portion of his regular potato field as may suit his convenience. The remainder of the field should be prepared and tilled as is the usual custom on the farm. If, however, it is not the custom to "shovel-plow" or "hill" the crop at about the third cultivation, it is desired that a few rows shall be treated this way for comparison.

A beginning along this line was made during the season of 1899 and several hundred farmers signified their desire to coöperate with the Station in the work. Many of these carried the work to a successful finish and have reported results to this Station. The data obtained are very valuable to the farmers securing the same, as well as to this Station and will appear in bulletin form later on. In many instances the suggestions of the Station were adopted only in part, still in nearly every case some substantial increase of crop is reported.

EXPERIMENTS SUGGESTED.

It is thought best to state the suggestions of the Station regarding the work under six different heads, so that each farmer may readily select one of more of them for experiment according as his circumstances will permit.

No. 1. Autumn vs. spring plowing.—

There may be soils where autumn preparation will be disadvantageous, but it is believed that in many localities where fall plowing is not practiced it will prove to be very beneficial and it is desired to have the experiment tried on small areas and results reported to this Station.

No. 2. Twice plowing vs. once plowing.—

As soon as the field is cleared of the previous crop, whether it be in sod, stubble or fallow, plow the land as deeply as the character of the soil will permit, and work it down well with the harrow and roller. If in August, sow crimson clover unless this crop is known not to succeed in the locality. If after August sow to rye or wheat. This autumn tillage will develop much plant food which the growing plants will take up and hold in readiness for next season's crop.

If crimson clover is grown it will also gather nitrogen from the atmosphere. (See Bulletin 135, p. 296.)

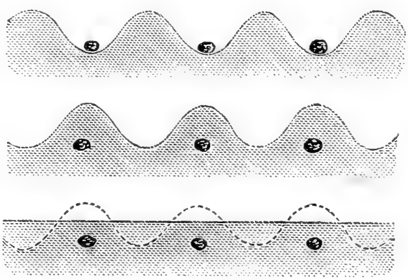
As early in the spring as the land will work plow the area, but not quite so deeply as recommended for the autumn plowing. At intervals of eight to fifteen days, from the date of this early plowing, till planting time, as the weather will permit, work the ground thoroughly with spring-tooth harrow or cultivator, thus killing several crops of young weeds, developing much plant food, and preventing the loss of moisture by evaporation. Sometimes it is an advantage to delay the planting that the land may receive another thorough working before the seed is put in.

This double working of the land — autumn and spring — coupled with the growing of a catch crop, as circumstances permitted, is believed to have contributed more towards securing such unusual average yields on the Station grounds, than any other part of the treatment the land has received.

Compare this double worked land with an area that has been worked but once, either autumn or spring, as circumstances make convenient.

No. 3. Early vs. late spring plowing.—

Plow an area as early in the spring as the land is fit to work and treat it till planting time as in No. 2. Compare this with another area plowed and fitted just before planting.



No. 4. Deep planting and harrowing before plants are up vs. shallow planting and without working till plants are well up.—

At planting time, whatever the tools or machinery used in doing the work, endeavor to secure the conditions that are obtained by the following plan: Open up with a double mouldboard or shovel plow, at appropriate distance (presumably at about 36 inches), furrows four or five inches below the general level, throwing the earth up in ridges between the rows. Place the seed

in these furrows at from 14 to 18 inches between the pieces. Then split the ridges, forming new ridges over the seed, which will be buried deeply, with furrows between the rows. Observe that the soil has thus all been thoroughly stirred to a depth of four or five inches. In about a week after planting, level down the ridges by means of a spike-tooth or smoothing harrow. This harrowing may be repeated, perhaps several times, before the plants are up.

Compare this area with another furrowed with a corn marker or other shallow working implement. If desired this area may be check rowed, the difference in the amount of seed used being charged against the thicker planting.

No. 5. Prolonged frequent level tillage vs. "laying by" at third cultivation.—

As soon as the rows can be followed, cultivate the space between them as deeply as it can readily be worked, keeping away from the plants sufficiently not to disturb their connection with the soil. This is the last deep cultivation the crop will receive. From this time on, at intervals of ten to fourteen days, cultivate lightly (about two inches deep), working as close to the rows as the size of the tops will permit. Cultivate after every rain-storm as soon as the soil is fit. Continue these shallow cultivations so long as it is possible to pass between the rows, narrowing the cultivator at each successive tillage to correspond to the space that is left between the spreading tops. A little earth will be thrown towards the rows by the cultivator blades, but do not attempt to ridge or hill the potatoes by hilling blades or the shovel plow. From seven to nine cultivations have been found most advantageous for the crop and it is well if the tillage is continued into August. Level tillage has given better results on the Station grounds than the "hilling" method, the advantage being greater in dry seasons.

Compare the area thus tilled with another that is "laid by" at about the third cultivation, which may be either hilled or left level.

No. 6. Protection against blight vs. protection against beetles only.—

For a description of the insect and fungous enemies that prey upon the potato, and their remedies, the reader is referred to

Bulletin 140, pp. 391, 403 (copies may be had upon application). It may be said, however, that no matter how thoroughly the preparation and tillage of the soil, unless a healthy foliage is maintained, satisfactory results cannot be secured. In the trials on the Station grounds in 1897, the gain due apparently to the use of Bordeaux mixture was 71 bushels per acre. In some seasons it might be more, in others less, according to the prevalence of the blights. A trial of Bordeaux mixture is earnestly recommended, but it is desired that no one will refrain from undertaking the tillage experiment because he is unprepared or unwilling to use the Bordeaux mixture. Bulletin 156 contains revised instructions for making Bordeaux mixture.

The best results have been obtained on the Station grounds by combining the twice plowing (autumn and early spring) with deep planting, in thoroughly fitted soil; prolonged, frequent, level tillage and spraying with Bordeaux mixture and Paris green.

It is not expected that each experimenter will be able to follow these suggestions in all their details, but that he will endeavor to secure the conditions described in one or more of the various experiments named above as near as the circumstances will permit.

As to the fertilizers applied, or the character of the seed used, the experimental area should be treated exactly like the rest of the field. This is not intended to be an experiment with fertilizers, but simply as to methods of culture. (For information relating to work with fertilizers see Circular No. 20.) It is recommended that good marketable potatoes be used for seed and cut so that each piece shall be of good size and have one or two strong eyes.

Care should be exercised in making measurements of land or product and in estimating yield per acre, that error shall not vitiate the results obtained. Circular No. 19, giving instructions for estimating yields from small areas, if not inclosed herewith, will be sent upon request.

Blanks upon which to report the dates and manner of performing the various parts of the work, and the results obtained, will be furnished to those who undertake the experiment. It is expected that an Experiment Station representative will be able to visit many of the experimenters during the season, to study the conditions that prevail and to advise in regard to the treatment of the crop.

Persons willing to coöperate with the Station in this work are requested to communicate with the undersigned at an early date.

If you know of farmers who are interested in improved methods of potato growing and whom you think will be willing to coöperate with the Station, please forward their addresses.

J. L. STONE,

Assistant in Agriculture.

A large number of farmers enrolled to experiment along some of the lines indicated in the circular. Many of them, however, simply adopted one or more of the features mentioned into the treatment of their general crop, not leaving a portion to be treated in the usual way for comparison. In such cases it is simply a matter of judgment on the part of the farmer whether or not the change of method has been a benefit or an injury. There are no data obtained by which to prove one way superior to the other. Some of the reports do not give the data in sufficient detail so that it is wise to attempt to draw lessons from them, others are very clearly stated. In the following pages are given summaries of some of the reports that have been received. These summaries are grouped together under various headings somewhat as laid down in the Circular No. 18.

Autumn and spring plowing vs. spring plowing only.—

From report of H. L. Beadle, Washington Co. Soil gravelly loam with gravel and sand subsoil. Received 15 loads per acre of stable manure. Part plowed seven to nine inches deep in December and replowed April 28th, five inches deep. The remainder of field was plowed April 28th, seven to nine inches deep. Harrowed at intervals of five to eight days till May 23d, the date of planting. Seed — merchantable tubers cut two or three eyes to the piece — one piece in a place 34x34 inches apart — variety Rochester Rose. Covered with a one-horse cultivator and harrowed twice before coming up. Worked three times with a weeder and six times with a one-horse cultivator between June 6th and August 3d when tillage ceased, a very little earth having been thrown towards the hills. Sprayed four times with Bordeaux mixture. The two parts were treated alike except as regards plowing. The tops looked thrifty

notwithstanding the drought, those on the fall plowed land living a few days longer than on the rest of the field.

The yield from the fall and spring plowed land was 261.7 bushels of merchantable potatoes per acre and from the spring plowed land 250.1 bushels, a difference of 11.6 bushels per acre in favor of the former.

This difference is not large enough to be very significant, but the whole experiment is instructive as showing that thorough tillage may secure a fine crop even in a drought-stricken season. The following remarks by Mr. Beadle will be interesting as illustrating the influence of these coöperative experiments among farmers.

"Of the many experiments that I have tried with corn and potatoes this one has been watched most closely by my friends. Many of them were here to-day to see the tubers dug and weighed (we had several experiments on with potatoes this season). The fall vs. spring plowing was most closely watched, though we could not see any difference while digging. The season has been so abnormally dry that the results are not satisfactory. I must try that again.

"I believe that the best results of my experiments have been that many of the farmers are following the advice of the Experiment Station. They give the credit to me, but it belongs to the men at Cornell, who keep drumming at the class that I belong to."

Early vs. late spring plowing.—

From report of Geo. W. Pierce, Ontario Co. Soil a dark loam. Part was plowed the first days of May, 10 inches deep — harrowed frequently till June 12th. Another part was plowed June 1st and also planted June 12th. Aside from the time of plowing the treatment was the same throughout the season.

The early plowed land yielded at the rate of 105.87 bushels per acre, while the late plowed yielded 62.31 bushels, a difference of 43.56 bushels per acre in favor of the early plowing.

At first glance it may seem improbable that the difference in time of plowing could affect the yield to such an extent, but when we recall that the season was abnormally dry, that the chief struggle of the crop was for moisture — that to produce 100 bushels of potatoes requires the transpiration and evaporation of about 300 tons of water — that an acre of unplowed land may lose in one week nearly 200 tons of water over and above what would be lost from an

acre of newly plowed land in the same time (see "The Soil," by King, pp. 155, 189) — then we may readily understand how the moisture that was conserved by early plowing might result in an increase of crop of 70 per cent above that grown on the late plowed land.

Result of deeper planting and level tillage.—

Robert Call, Genesee Co. Soil deep sandy loam with sandy subsoil. A clover and timothy sod dressed with a light application of stable manure and plowed seven inches deep just before planting, June 8th. Rolled and harrowed three times, marked two feet ten inches each way. Covered with a common potato coverer, leaving a ridge over the rows. On the special plat a one-horse plow was used to make furrows deeper one way. After a few days the ridges were scraped off level. Both plats received three or four cultivations. The only difference in treatment was in depth of planting and that while the field was hilled at the last working the special area was left level.

The result was that the shallow planting and hilling yielded 132 bushels per acre, while the deeper planting and no hilling yielded 156 bushels.

Area of special plat, one-eighth of an acre. Mr. Call writes "Shall try a larger piece next year."

Shallow planting and hilling vs. deep planting and level culture.

Geo. W. Pierce, Ontario Co. Soil a dark loam — planted June 11. One plat was marked shallow, seed covered with plow and hilled at last cultivation. The other plat was furrowed deeply, covered with plow and left level at last cultivation.

Result: The shallow planted and hilled plat yielded at the rate of 74 bushels per acre, while the deep planted and level tilled yielded 107 1-2 bushels, a difference of 33 1-2 bushels in favor of the latter.

From report of R. E. Barden, Tioga Co. Soil a loam with clay or rock subsoil — plowed about seven inches deep. Part was marked with a corn marker three or four inches deep — seed covered with a cultivator, worked five times — hilled. Another part was furrowed five or six inches deep — seed covered the same as the other plat, harrowed with a spike tooth harrow ten days after planting — worked seven times without hilling.

Result: The first plat yielded at the rate of 95 bushels per acre and the second 120 bushels, a difference of 25 bushels per acre in favor of the deep planting, longer continued and level tillage.

Deep vs. shallow planting.—

C. L. Frost, Schuyler Co. Soil, a clay loam with hardpan subsoil. Both plats were treated alike except that while the field was furrowed three to four inches deep, the special area was furrowed seven inches deep. Both were covered with a plow and received frequent level tillage.

Result: The shallow planting yielded 140 bushels per acre and the deep planting 171 bushels, a difference of 31 bushels in favor of the deep planting.

Hilling vs. level culture.—

Wm. C. Buell, Ontario Co. Soil, varying from a gravelly to a clay loam — a timothy sod, no manure. Plowed in November and harrowed May 2d, 12th and 25th. Planted May 27th, furrowed four to five inches deep, seed dropped one piece in a place 28 inches apart, and covered with a potato coverer. Harrowed 10 days after planting. Part was cultivated four times, and shovel plowed; another part was cultivated six times and not shovel plowed.

Result: The first yielded 91 1-2 bushels per acre, and the other 102 1-2 bushels, a difference of 11 bushels per acre in favor of continuing level tillage.

Another plat was treated similarly to No. 2 except that the seed was dropped 14 instead of 28 inches apart and covered by turning a furrow from either side over the seed so that all the soil between the rows was thoroughly stirred. It also received one more cultivation.

Yield, 126 1-2 bushels per acre as compared with 102 1-2 bushels, a difference of 25 bushels per acre in favor of the closer planting and more thorough working of the land.

Hilling vs. level tillage again.—

Clark A. Storms, Orleans Co. Soil, loam with a clay subsoil — a clover sod dressed with stable manure plowed under. Plowed May 15th about eight inches deep. The field was well fitted, well tilled and sprayed four times with Bordeaux mixture. One part was shovel plowed at the fifth and last working, the other was tilled level.

Result: Hilled, 61 bushels per acre, level tillage, 78 bushels — a difference of 17 bushels in favor of level tillage.

This crop suffered severely from the extreme drought which was emphasized by the late plowing, and the undecayed sod and manure under the furrow. It was in such condition that the shovel plowing at the last working did its worst work.

Harrowing after planting with five cultivations vs. not harrowing and two cultivations.—

V. C. Wood, Lewis Co. Soil, gravelly loam with clay subsoil—dressed with 400 lbs. per acre of one-four-eight fertilizer,* plowed May 3d, six inches deep, planted June 3d. The plats were fitted and planted alike, and both were sprayed with Bordeaux mixture. One was harrowed between planting and coming up and received five level cultivations; the other was not harrowed and received two level cultivations.

Result: 162 bushels per acre from the latter, and 176 bushels from the former, a difference of 14 bushels per acre in favor of five cultivations. However, owing to the smaller proportion of culls on the special area the gain in merchantable tubers was 27 bushels per acre.

Very similar to the above is the report of Fay C. Gordon, Lewis Co. The plats were treated alike except that the special area was harrowed before plants were up, received five cultivations (not hilled) and once sprayed with Bordeaux mixture, while the other plat was not harrowed, was cultivated twice and hilled twice, and not sprayed with Bordeaux.

Result: 172 bushels per acre for the former, and 170 bushels for the latter—practically no difference.

We are pleased to introduce this report here to call attention to the fact that identical results may not be expected on different farms even if in the same county and during the same year. However, the fact that impresses us most strongly as we look over these reports is that so very few of the efforts to follow the suggestions of the College as to methods of tillage give negative or neutral results. Fully 85 per cent of the reports show positive results that indicate financial gain.

Six cultivations hilled vs. seven cultivations not hilled.—

E. C. Corwin, Cayuga Co. Soil, clay loam with yellow clay subsoil. The two plats were treated every way alike except as stated above.

* One per cent nitrogen, 4 per cent phosphoric acid, 8 per cent potash.

Result: The plat cultivated six times yielded 187 bushels per acre, while the plat cultivated seven times yielded 194 bushels, a gain of seven bushels for one extra cultivation.

Three extra cultivations.—

A. B. Hayes, Niagara Co. Soil, sandy with a white sand subsoil. Plats treated every way alike except that the special area received three extra cultivations once in a row.

Result: The field culture yielded 119 bushels per acre and the special area 140, a gain apparently due to the three extra cultivations of 21 bushels.

Three cultivations hilled vs. five cultivations level.—

Emery Osterhout, Schoharie Co. Soil, a yellow loam. The plats were treated alike except as stated above, and that while the field was gone over once with a spike tooth harrow and once with a weeder before plants were up, the special area had an extra working with the harrow.

Result: Three cultivations, hilled, 152 bushels per acre; five cultivations, level, 167 bushels, a difference of 15 bushels per acre in favor of the latter.

Three cultures hilled vs. nine cultures level.—

H. L. Beadle, Washington Co. This experiment was in the same field as that given from Mr. Beadle on page 198. The preparation and the planting were the same, and both were sprayed twice with Bordeaux mixture. Nothing was done to the first plat till plants were up, after which it was worked three times, hilled and hand hoed, the last work being done July 6th. The other plat was dragged twice before plants were up, and cultivated nine times level, the last working being Aug. 8th.

Result: The three cultures, hilled, gave 252 bushels per acre, while the nine cultures level gave 311 bushels, a difference of 59 bushels in favor of the continued level culture.

Mr. Beadle has followed this experiment of hilling vs. level tillage of potatoes for several years, and in his letter gives the following summary:

In 1895 the difference in favor of hilling was 73 bushels.
In 1896 the difference in favor of hilling was 14 bushels.
In 1897 the difference in favor of level culture was 37 bushels.
In 1899 the difference in favor of level culture was 59 bushels.

In the season 1895 there was abundunt moisture throughout the State and possibly on this farm an excess. This brings out very clearly that the benefits of level tillage are manifest in dry seasons rather than at other times and that hilling may be a benefit when we are contending with too much moisture.

Five cultures, hilled, not sprayed, vs. seven cultures level, not sprayed, and vs. seven cultures, level, sprayed.—

Geo. S. Reeves, Wayne Co. Soil, gravelly loam with clay subsoil, light dressing of stable manure. The three plats were treated alike except as stated above.

Result: Five cultures hilled, not sprayed, yielded at the rate of 123 bushels per acre; seven cultures, level, not sprayed, yielded 132 — a gain of nine bushels, and seven cultures, level, twice sprayed with Bordeaux mixture, yielded 144 bushels, a gain of 21 bushels over the first.

Mr. Reeves estimates the cost of material, time of team and men spraying (two applications) at $3.50 per acre.

Check-rowed, hilled and not sprayed vs. drilled, cultivated, level and sprayed.

J. M. Haywood, Rensselaer Co. Soil, a loam with clay subsoil. Plowed April 29th, six inches deep and planted May 11th. The regular field was furrowed with a plow 36 inches apart each way — one piece of seed in a place and covered with a plow. Not harrowed before up — cultivated four times and hilled — not sprayed. The special area was prepared the same but furrowed one way and seed dropped one piece in a place about one foot apart; covered with a plow and ridges harrowed down before plants are up. Cultivated five times, level and sprayed three times with Bordeaux mixture.

Results: The check-row area yielded at the rate of 100 bushels per acre, 30 bushels of which were culls, while the drilled area yielded at the rate of 222 bushels per acre with only 18 bushels of culls.

In this experiment the improved method of growing potatoes comes into striking contrast with the old method and shows a gain of more than 100 per cent. Mr. Haywood remarks, "I have learned a number of things this summer about raising potatoes, thanks to the teaching of the College."

The old method vs. the improved method.—

J. I. Parent, Saratoga Co. Soil, a loam, with loam subsoil. One plat was an old sod plowed about May 1st, no manure, harrowed four times, check rowed 39 inches apart, worked three times and killed at the last cultivation; not sprayed. Variety, White Star, **yield 87 1-2 bushels per acre.** The other plat had grown strawberries. In 1897, the strawberries were dressed with 1,600 pounds per acre of a good fertilizer (analysis not given), no manure in 1898. In 1899 the land received a light dressing of horse manure and 500 pounds of fertilizer. Plowed May 1st, seven inches deep. As to fitting and planting "followed bulletin directions as near as possible." See page 197. Harrowed twice before plants were up and once with weeder just as plants were coming through. Cultivated level seven or eight times — last time July 25th. Sprayed part of them with Bordeaux mixture three times.

Result: Variety, White Star, not sprayed, 146 2-3 bushels per acre; the same sprayed, 292 bushels per acre — a gain of 159 1-6 and 204 1-2 bushels per acre, respectively over the old method. Some Carman No. 1 on the same plat, not sprayed, yielded 275 bushels per acre, while the same sprayed yielded 298.3 bushels.

This experiment illustrates two distinct systems of farming. Mr. Parent writes, "I wished to compare special culture with our old way on sod land. Special culture has paid me and I wish to thank the College for its efforts in this, as well as in other directions."

Four cultures, hilled, and once sprayed, vs. seven cultures, level, and three times sprayed.—

Neil Merritt, Niagara Co. Soil, a gravelly loam with clay subsoil; plowed about May 1st, seven inches deep, harrowed once a week till planting, May 23d; furrowed and covered with a plow, seed cut to two eyes and dropped one piece in a place 18 inches apart; leveled and dragged twice before coming up. Both plats alike to this point — further treatment as stated above.

Results: Four cultures, hilled and once sprayed with Bordeaux mixture gave 138 1-3 bushels per acre, of which 20 bushels were culls; while seven cultures, level, and three times sprayed gave 205 bushels, of which six bushels were culls — a gain of 81 bushels per acre of merchantable potatoes for the better treatment.

Spraying five times with Bordeaux mixture vs. no spraying.—

Hubbs Bros., Madison Co. Soil, sandy with a sandy subsoil, dressed with 15 loads of stable manure per acre. This crop was grown by the improved methods except that a part was left unsprayed.

Result: The unsprayed plat yielded at the rate of 247.2 per acre, while the sprayed portion of the field yielded at the rate of 283.8 bushels — a gain of 36.6 bushels apparently due to the spraying.

The Hubbs Bros. write as follows: "Having heard a representative of the College lecture on potato culture last year we used level culture on part of our field and had the largest yield in this section; so this year we used level culture on the whole field."

Hilling vs. continued frequent hand tillage.—

Ellen R. Hall, Cattaraugus Co. Soil, a sandy loam, plowed April 24th, eight inches deep, harrowed and rolled April 25th. Thoroughly fitted and planted June 10th; rows 36 inches apart, sets 14 inches apart; planted five inches deep, not worked till up. July 8th worked with a hand weeder; July 15th cultivated by horse. To this time both plats were treated alike. July 25th one part was hilled up with a hoe and laid by. After July 15th the other plat was worked every Wednesday and Saturday morning with a hand cultivator, twice in a row, set three inches deep, till the tops were killed by frost October 26th.

Results: The hill area yielded at the rate of 122 1-2 bushels per acre, while the hand tilled area yielded at the rate of 90 bushels, indicating that the very frequent and persistent stirring by hand was not productive of good results.

Good treatment with hilling vs. superior treatment and level tillage:

G. W. Hamilton, Madison Co. Soil, a sandy loam with clay subsoil. Plowed April 15th, nine to ten inches deep. Harrowed and rolled several times before planting May 13th. Furrowed with shovel plow 36 inches between rows and five to six inches deep. Seed, Rural New Yorker No. 2, cut to two eyes rejecting the small eyes at the "seed end" — two pieces in a place, 15 to 18 inches apart covered with shovel plow seven inches deep and harrowed twice before plants were up. Up to this time the plants were

treated alike except that the special area received a dressing of 600 pounds of fertilizer per acre (kind not stated) and one piece of seed in a place instead of two. After plants were up the regular field received three cultivations and were "laid by," hilled August 1st. No Bordeaux mixture used on this plat. The other plat was worked level eight times, up to August 18th, when vines were so large that further cultivation seemed unadvisable. This plat was sprayed four times with Bordeaux mixture.

Result: The regular area yielded at the rate of 200 bushels per acre and the special area 390 bushels, a gain of 190 bushels per acre in favor of superior treatment.

Mr. Hamilton writes: "Only large smooth potatoes were used, and the seed was cut but a short time before planting. The flea beetles seemed to come out of the ground with the potatoes and were always at work. The rows that were not sprayed with the Bordeaux mixture showed black spots on the leaves quite early in the season and were dead much sooner than the special area. Rains washed the Bordeaux off to a considerable extent and the special area showed the effect of blight. I think perhaps if the Bordeaux mixture had been applied sooner and continued later the blight could have been kept off. The potatoes were very large and smooth and no rotten ones were found. I have found out that it pays to work potatoes good."

Brief and to the point:

Some of the reports possess the merit of briefness if not of minuteness. One from Cattaraugus county gives only the following to distinguish between the two facts:

"Four rows 145 feet long your way six bushels. Four rows 145 feet long my way four bushels."

While this report does not offer to readers of this bulletin many suggestions as to methods of potato culture, the experiment was no doubt very interesting and instructive to the farmer conducting it, and the latter object is equally important with the former. In fact very many of the reports that we cannot use in a bulletin give evidence that the farmer making the experiment has received benefit. And not only does the farmer himself receive benefit, but his neighbors watch the experiment and are led to adopt the improved methods.

In illustration of this we quote from the letter of Mr. Geo. F. Ingalls of Washington county. He writes :

" One of my neighbors last spring when I was planting stood and saw the way I was doing it, and when he came to see a furrow from both sides turned over on top of the potatoes that had been dropped, he went off in disgust without saying a word to me, but he said to another fellow, who told of it, 'I did suppose that Ingalls had fair judgment. He seems to have about other things, but I guess he has read a little too much about farming for his own good.' Well, that fellow kept watch of the potatoes all summer. They were where he had to go right by them nearly every day, and he was there when I dug them. He then said, 'Well, George, I'll give it up. I thought when you were planting them that you were throwing away a good deal of time and the use of a good piece of ground, but I want to try a piece myself next year the way you planted this.' "

Enough reports have been quoted to show that the methods that have given such satisfactory results on the Station grounds are productive of similar results in the hands of farmers on their own lands. In addition to the reports that are abstracted above we have received reports more or less complete from the following experimenters, some of them showing as marked results as any presented herein :

Chas. W. Abell, Schoharie county.
Floyd E. Blowers, Madison county.
R. K. Bull, Jefferson county.
J. B. Cole, Erie county.
L. Crawford, Lewis county.
Geo. R. Schauber, Saratoga county.
G. A. Bliss, Tompkins county.
B. G. DuBois, Ulster county.
Geo. W. Bundy, Steuben county.
J. G. Congdon, Cattaraugus county.
C. H. Curtis, Oneida county.
H. S. Hulburt, Onondaga county.
J. T. Dunnigan, Allegany county.
Lorenzo Green, Tioga county.
Frances E. Harvey, Tompkins county.

J. N. Holmes, Oswego county.
Henry Hulett, Chautauqua county.
D. C. Lincoln, Cayuga county.
C. H. Love, Chautauqua county.
H. H. Lyon, Chenango county.
Fred Manning, Tioga county.
John U. Metz, Erie county.
G. Palmer, Chautauqua county.
J. P. Porter, Tompkins county.
John D. Teal, Dutchess county.
Geo. C. Wilkins, Saratoga county.
R. K. Wilson, Steuben county.
John A. Fraleigh, Columbia county.
Fred W. Hadden, Wayne county.
C. D. Hillernan, Schuyler county.
Geo. W. Huff, Genesee county.
D. P. Jones, Schoharie county.
M. M. Lansing, Montgomery county.
L. F. Lyman, Genesee county.
J. L. Manderville, Tompkins county.
Milton Manrow, Cayuga county.
H. J. Richardson, St. Lawrence county.
Levi G. Pettit, Niagara county.
James M. Stone, Chautauqua county.
Geo. F. Tyrrell, Wayne county.
C. B. Waterbury, Madison county.

As stated elsewhere, 85 per cent of the reports received indicate, as a result of the adoption of some of the suggestions of the College, a gain that would seem to be profitable from a financial point of view. Some of the gains are extremely profitably secured.

Perhaps a few comments are needed in regard to the adoption of the methods that have given good results in some of these experiments. Deep planting has almost invariably given better results than shallow; but very deep planting should not follow shallow plowing. The furrows opened to receive the seed should not go to the bottom of the soil that was stirred by the plow. If it is desired

to plant six inches deep, the land should be plowed eight or ten inches deep.

Then again land that has never been plowed deeper than five or six inches should not the next time be plowed ten. The deepening process should be gradual — an inch or so a year. More "new dirt" may safely be turned up in autumn than in spring.

Some fear that deep planting will make the harvesting more difficult; if coupled with the deep planting the cultivation of the crop is continued late in the season, the mellowness of the soil and the freedom from late summer weeds compensate for the tubers lying a little deeper in the soil.

Again, some claim that if they do not "hill up" the plants many tubers will be damaged by exposure to the sun. If however the land has been deeply and thoroughly prepared and the planting is sufficiently deep so that there is plenty of room in the mellow soil for the tubers to develop beneath the surface there will be few "sunburns;" but if the fitting and planting are shallow, hilling is necessary to protect the tubers.

There is some complaint that the diggers in common use in the potato growing sections of the State do not do good work in level tilled fields. They are so constructed that the wheels need to be let down into the furrows between the rows in order that the digger may get well under the hills. This is a fault of construction that will be corrected by the manufacturers as soon as level tillage becomes general, and if in order to use the machines now on hand shovel plowing is necessary, it is better to do it at harvest time, just ahead of the digger.

Now a word about experiments in general. It seems wise to distinguish between a "trial" and an "experiment." A farmer is convinced that it is well to spray potatoes with Bordeaux mixture. He takes the necessary steps to that end and sprays his crop. He makes a trial of spraying. He may "think" that the spraying was a benefit. Another farmer sprays a part of a field and leaves another part unsprayed for comparison. He harvests a measured area from each portion of the field and measures or weighs the product. He "knows" whether the spraying increased the crop and if he kept account of time and material consumed, he "knows" whether it

was a profitable operation. We are thoroughly convinced that farmers need more of the facts and discipline that can be obtained from "experiments."

A word of warning.—

This bulletin is intended to impress upon farmers the importance of thorough tillage of the soil. It is important right here to call attention to the fact that intensive tillage results in a rapid consumption of organic matter and if steps are not taken to restore this to the soil its physical condition will decline and production will fall off. Every opportunity should be embraced to grow sod or cover crops to turn under to help maintain the supply of organic matter in the soil, and dressings of stable manure are probably as valuable on account of the organic matter added to the soil as for the nitrogen, phosphoric acid and potash they supply.

It is desired to continue this line of experimentation among the farmers of the State and we invite those who are willing to coöperate to correspond with this office.

Bulletin 192. **A 7.** **June, 1901.**

Cornell University Agricultural Experiment Station,

ITHACA, N. Y.

ENTOMOLOGICAL DIVISION.

Further Experiments Against

THE PEACH-TREE BORER.

By M. V. SLINGERLAND.

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ITHACA, N. Y.

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The regular bulletins of the Station are sent free to all persons residing in New York State who request them.

FURTHER EXPERIMENTS AGAINST THE PEACH-TREE BORER.

Sanninoidea exitiosa Say.

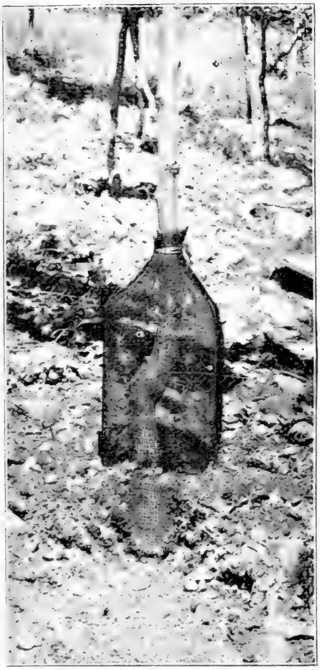
Order LEPIDOPTERA; Family SESIIDAE.

51.—*Stedman's wire-cage protector in position on a peach tree in our experimental orchard. Theoretically a perfect protector, but practically a useless device.*

In Bulletin 176, issued in December, 1899, we published a detailed account of the life and habits of the peach-tree borer, and the results of five years of experimentation with methods of combatting it. Soon after the bulletin was issued Professor J. M. Stedman of the Missouri Experiment Station, who had published the results of some experiments against the pest in Missouri in 1898, wrote us as follows:

"I received your most excellent bulletin on the peach-tree borer, and, naturally, I looked to see your results with the use of protectors and

washes. I at once became interested because of the great difference between your results and mine. But I think I can account for your failure of the wire netting protector. I have no doubt that the young larvæ crawled down the trunk right through your netting because nothing was there to prevent it. (See figure 52.) In my experiments I stopped the space at the top between the wire netting and the tree with cotton (see figure 51); and, although I did not know at the time, I now believe from your failure, that the larvæ became entangled in my cotton and could not get down or around it. I did not think of your method of attaching the top, and used the cotton as the simplest method. Now I believe it was the fortunate method, for I never could find the borers in those cages, nor could I find one borer in two hundred trees where I used the wooden wrappers (see figure 53), which I likewise stopped at the top with cotton. I regard the wooden wrapper as the most popular, simply because it is so cheap, but the wire netting is just as good, and if both be pushed into the ground and the tops stopped with cotton, they form a perfect protector with us here. One gentleman told me that he followed this wooden wrapper plan in two orchards of 10,000 trees, but lacked enough for 300 trees which he did not wrap, and that he found these 300 trees badly infested with borers, but could find none below the wrappers in the treated ones.



52.— *Cornell wire-cage protector in position on a peach tree in experimental orchard. A useless device.*

"But we also have another difference between our results that I do not understand. I tried coal or gas tar in every way from a small band to a large application covering the entire trunk, and on both young and old, healthy trees as well as on sickly ones, and I killed every tree in spite of all I could do. I tried it on not only

peach but on apple, plum, apricot, pear and several shade trees, and I killed every one of them. I even found that I was not alone in this regard, for there were many at our State Horticultural Society's meeting who had done likewise. All our people who have tried it have killed the trees, with but one exception. Of necessity, therefore, I gave up all hopes of ever thinking of coal tar, or even mentioning it, for trees, and now you have used it without injuring the trees. How can this be? It cannot be done here in Missouri, I can assure you — not with our coal tar — and why I cannot imagine. Our tar is made from soft coal, and I suppose your tar is also; but even if from hard coal, I do not see how that can make the difference, and I cannot account for it in the climate, etc. This is a puzzle, and shows the need of repeating the same experiment in different widely separated regions of the United States.

"Again we differ in the effects of the washes of lime, etc., etc. The wash I recommended is now used in many large orchards with excellent results both as regards actual protection and retaining qualities. It does not flake off here as it does with you, and it remains in working order a month and a half to two months; it is not as perfect as the wrappers, to be sure, but it should be used on the trunk and large limbs above the wrappers to keep the borers out above. It surely does excellent work here, and part of its better results in this State may be due to the fact that the trunks of our trees are only a foot or a foot and a half high, that is, peach and apple trees; and they are thus protected from the rains and the sun, while the trunks in New York are very long in comparison."

We at once decided to continue our experiments along the lines suggested in the above letter. And at our request, Professor Stedman sent us some Missouri coal tar and some of his thin wooden wrappers, shown in figures 53 and 54.

After first digging out the borers in our trees, we made the applications on June 29, 1900, using the same care as in our previous experiments to give each method the best possible chance. Our trees now average from two to four inches in diameter.

The Missouri coal tar was not so thick as the New York tar we used, hence it was more easily applied with a brush and a thinner coating on the bark resulted; it also dried out sooner and was not sticky as long. Thirty-four trees were treated, six of which had been treated each year for three years previously with New York tar.

53.—*Stedman's wooden wrapper in position on a peach-tree in our experimental orchard. No more effective with us than a cheaper paper protector.*

We caged twenty-one trees with the wire netting according to Stedman's directions, as shown in figure 51, leaving a space of from one-half inch to an inch between the wire cylinder and the trees. It required pieces of the netting about eighteen inches square, and small wires were tied around each cylinder in four or five places to keep it intact. A very liberal amount of cotton was stuffed in at the top, and we examined the cages from time to time to see that they kept in working order. We found these wire protectors were more easily applied but more expensive than the wooden ones.

The wooden wrappers (see figure 54) were thin veneer boards about ten inches wide and eighteen inches long, with three small wires fastened through holes near one edge. They cost about three

dollars per thousand, says Stedman. It required two of these wrappers to properly encircle most of our trees, as shown in figure 53. We put them on twenty-one trees in the same manner as we did the wire cages.

On April 30, 1901, we examined the treated trees, and also thirty-four untreated ones to serve as checks to the experiments. The results in tabulated form are as follows:

MISSOURI GAS TAR.

When applied.	Number of trees treated.	When examined.	Number of trees infested.	Number of borers found.	Largest number of borers in one tree.	Effect of application on tree.
29 June, 1900	34	30 April, 1901	1 (3%)	1	1	None

STEDMAN'S WIRE CAGE.

29 June, 1900	21	30 April, 1901	18 (86%)	43	5	None

STEDMAN'S WOODEN PROTECTOR.

29 June, 1900	21	30 April, 1901	6 (29%)	6	1	None

UNTREATED OR CHECK TREES.

	34	30 April, 1901	22 (65%)	50	7	

The Missouri gas tar kept out all the borers but one, and *it did not injure the trees in the least.* Gas or coal tar is the most effective application we have ever used to keep out the peach-tree borer. But do not fail to read our precautionary hints in Bulletin 176 before applying it.

The wire cage protectors, applied as Stedman directed (figure 51), which should have been *theoretically more effective* than the ones we used in 1894–1896 (figure 52), were *practically no more effective* than the latter. For, a larger percentage of the trees

treated with Stedman's wire cage were infested with borers and there were nearly twice as many borers in the caged trees as in the same number of untreated trees only a few feet distant. We had hoped much from this arrangement of the wire cage protector, but it is another case of misplaced confidence. We are unable to get the slightest practical evidence in favor of these wire cages as a protection against the peach-tree borer. In our experience they are worse than no treatment of any kind, and we doubt if a wire cage can be practically applied in such a way as to keep the peach-tree borer out of trees in New York.

54.— *Stedman's wooden wrapper ready to be put around the tree.*

As the table shows, *Stedman's thin wooden wrappers or protectors* (see figure 53) were quite effective in keeping out the borers; while nearly a third of the treated trees contained borers, only a single borer was found in each tree. But they were no more effective than the less costly and more readily obtainable tarred paper protector that we used in 1894–1897 (see Bulletin 176, p. 10). We were not favorably impressed with these wooden wrappers and would use the cheaper paper wrapper instead in New York. Many millipedes and wireworms had gathered inside about the bases of our trees, and hundreds of the egg-sacs of spiders were attached to the inner surface of the wrappers. A Kansas fruit grower also states (Rural New Yorker, Oct. 27th, 1900, p. 718):

"For several years we used in our 60 acres of young orchard the wood-veneer wrappers to protect the trees from rabbits. But we found them objectionable for several reasons. Under the influence of the weather they warp and twist, curl and split, so it is impracticable to remove a large number in Spring and replace them in the

Fall. I found more than one worm's nest snugly built within the wrapper. If left on the year around, as was our practice, the bark becomes bleached and unhealthy. But the worst thing was that they afforded such shelter for the woolly aphis that in late summer the whole trunk beneath the wrapper became blue with them."

Note on a Fungous Disease of the Peach-tree Borer.— While digging out peach-tree borers in June, 1900, we found one dead borer presenting the appearance shown in figure 55. Its body was filled with a fungous growth which also protruded from the head in four white root-like growths. We could not determine if the fungus was the primary cause of the death of the borer. It was an interesting looking borer and worthy of more than this brief note.

55.—*A curious fungus found growing in a peach-tree borer, twice natural size.*

Summary: Even Missouri gas tar did not injure our New York peach trees, and it kept out practically all of the borers. First try tar on only a few trees.

Stedman's wire cage was no more effective in New York than any other form of such a cage. Such wire cages afford no protection against the peach-tree borer.

Stedman's wooden wrappers were not more effectual than cheaper paper wrappers.

MARK VERNON SLINGERLAND.

Bulletin 193. **June, 1901.**

Cornell University Agricultural Experiment Station,

ITHACA, N. Y.

BOTANICAL DIVISION.

STUDIES OF SOME SHADE TREE AND TIMBER DESTROYING FUNGI

By GEO. F. ATKINSON.

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STUDIES OF SOME SHADE TREE AND TIMBER DESTROYING FUNGI.*

BY GEO. F. ATKINSON.

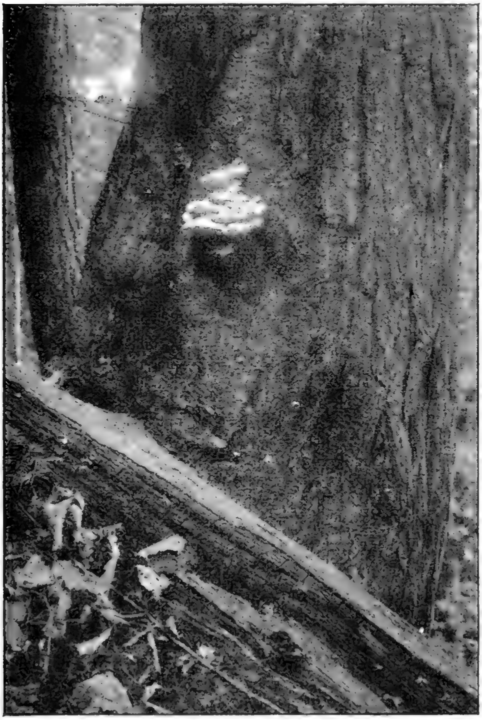
A great deal of attention has been given in the past to the study of injuries to trees caused by the microscopic fungi, but comparatively little study has been made of the relation of the larger fungi to the destruction of trees and timber. The most notable work which has been accomplished in this direction is that of Robert Hartig of München, Germany, whose contributions have appeared in the publications of the "Forstlische Versuchsanstalt," in his book on the Diseases of Trees, and in other places. During the past two years there have appeared several excellent bulletins from the Missouri Botanical Garden and from the U. S. Dept. of Agr., giving in detail the results of some work by H. von Schrenk, of Washington University, St. Louis.

About five years ago the writer began studying the injuries which some of the higher fungi produce upon shade trees and timber trees. Very little of this work has as yet been published. Use has been made, however, of some of the studies and photographs accumulated in the progress of the work, in the author's "*Mushrooms; Edible, Poisonous, Etc.*" (1900), and in other places; while a short article was published on "Some Wood Destroying Fungi," as special report No. 9 in the Geological Survey of Louisiana, Feb., 1900. It has been my plan, as far as possible, to select one or more individual cases and then endeavor to trace the history of the relation of the fungus and its host. This would include a study of the present conditions, and an effort to determine, by examination, the time in the

* The principal facts in this paper were presented before the Mass. Hort. Soc., Boston, Mar. 1901.

past when the fungus entered, the mode of its entrance and progress, as well as the probable cause of the wound which provided the entrance court for the tree enemy. In a number of cases these have been worked out quite satisfactorily. The studies have been made in New York State, chiefly at Ithaca and in the forests of the Adirondack mountains.

A word might be said at the outset in regard to the relation of these wood destroying fungi to others, as well as in regard to their structure. They are among the higher fungi and belong to the larger group known as the *Hymenomycetes* to which the mushroom also belongs. In fact it is becoming customary with some to apply the term "mushroom" to all of the *Hymenomycetes.* However widely these plants differ in their form and structure, they all agree in the general character of their fruiting surface. It forms a thin layer or "membrane," covering definite parts of the fruit body, and consisting of innumerable club-shaped cells standing side by side. Each one of these club-shaped cells is called a *basidium*, and usually bears four spores.



56.—*Polyporus borealis. Fruit bodies growing from wound on hemlock spruce.*

There are several large families, or orders in the group. I will call attention to a very few in each family in order to show more definitely the form and general character of the species examined here. In one of these families the fruit body is often spread over

the surface of the wood in thin smooth patches, or some forms are shelving, when the under side is smooth and is the fruiting surface. These belong to the family *Thelephoraceæ*. A few of its members are very destructive to wood and some are parasites on trees. In another family the members are known as "coral fungi," or "fairy clubs" a large number of them belonging to the well known genus *Clavaria*, from which the family name *Clavariaceæ* is derived. The fruiting surface is distributed all over the surface of the plant. To a third family, *Hydnaceæ*, belong the "hedgehog fungi," with the fruiting surface on spines, a few species of which are well known. A number of the members of the two last named families grow on wood, but often appear in late stages of decay. A few species like *Hydnum septentrionale* on maple, and *H. schiedermayeri* on apple, are destructive.

57.—*Polyporus borealis, section of fruit body.*

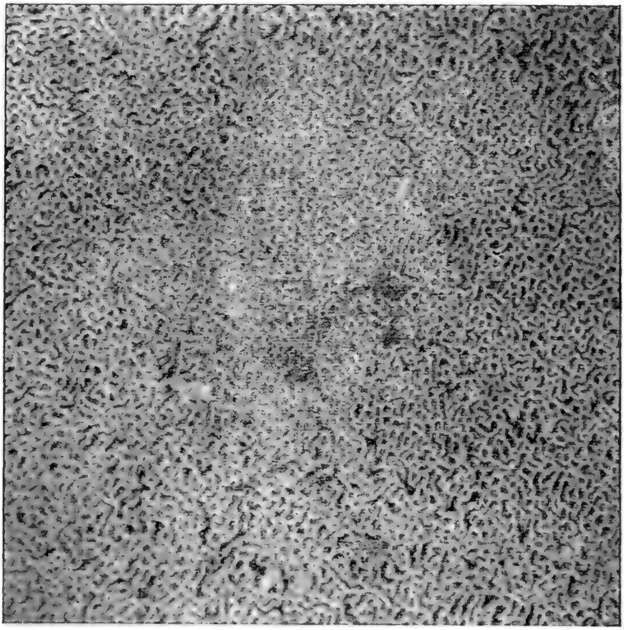
The two largest families are known as the *Agaricaceæ*, to which the common mushroom belongs, and the *Polyporaceæ*. In the latter the fruiting surface is in the form of a honey-comb on the under side of the fruit body. It is to this last named family that the species belong which are treated of here.

The gross characters, those which are quite easily made out without the aid of a microscope, are chiefly the ones presented here, since a detailed account of microscopic structures and changes brought about in the wood by the action of the fungus, are rather too technical for full treatment in this paper.

Polyporus Borealis.

Polyporus borealis occurs on pines, spruces, the hemlock, etc., and is widely distributed over the North Temperate Zone. It

occurs on living or dead trees. It is a "wound" parasite, entering through broken branches, through wounds caused by impact of falling timber, or where the cambium has been scorched by fire. The fruit bodies are entirely white. When old or dry they often take on a pale yellowish tinge. They are shelving, the cap attached directly to the tree, broad at the free end and tapering somewhat in a wedge-shaped manner toward the base. They are rarely single, and sometimes scattered over the trunk. They usually occur, several



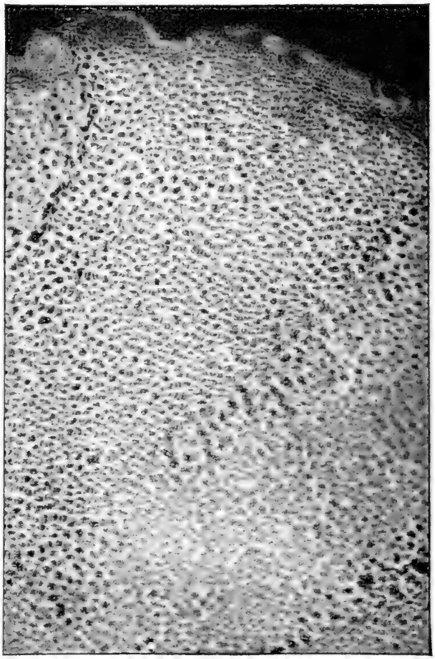
58.—*Polyporus borealis, Hymenium with sinuous pores.*

close together overlapping in an imbricated fashion, and joined at the base in a common trunk at the exit from the tree.

The fruit bodies are rather soft and spongy. They last only for the season. They are 10 to 20 cm. (4 to 8 inches) long by 6 to 15 cm. broad. They form larger masses where several are joined. The upper surface is rough with coarse tufts of mycelium giving it a very shaggy or sodden appearance. The honey-combed surface is below. The hymenium consists of quite regular pores with rounded

openings in some specimens, or irregular, elongated and sinuous pores in other specimens, resembling the pores of *Dædalea*. But they are evidently sunk in the substance of the cap and therefore lack the essential character of that genus. The walls of the pores are thin, and the edges often irregular and jagged.

There are two cases of its occurrence on living coniferous trees which I have carefully studied. One case is that of a hemlock spruce (*Tsuga canadensis*). The other is that of a red spruce (*Picea rubra*), the common timber spruce of the Adirondack region.



59.—*Polyporus borealis, Hymenium with rounded pores.*

The hemlock spruce was a large tree, 60 cm. (2 ft.) in diameter, on a steep slope in one of the deep gorges (Fall Creek) at Ithaca, N. Y.

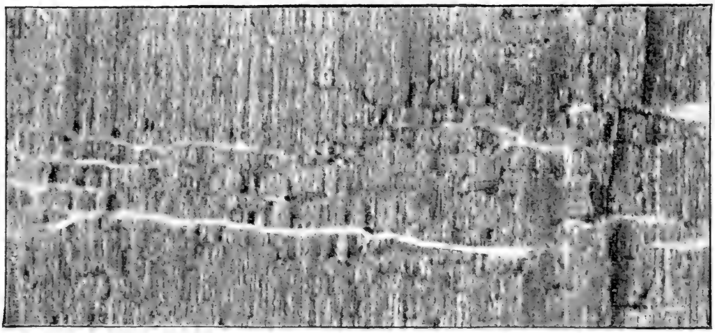
This example was observed in the autumn of 1899. The fruit body of the fungus was situated at a large wound on the trunk near the base. It consisted of several caps closely joined at their origin from the trunk of the tree. This is well shown in the several photographs. A section through the entire fruit body (Fig. 57) shows the radiating lines formed by the general direction of the mycelium in the caps from their common origin in the tree trunk.

One of the photographs gives us a clue to the manner in which the mycelium of the fungus entered this particular tree. The log, lying in the foreground, close by the trunk of the affected tree, tells the tale. This tree in its descent, years ago, struck the slightly projecting base of the standing hemlock, and knocked off a large area

of the bark and cambium, or growing region, at this spot. This wound was too large and the tissues too much bruised to permit rapid healing over. It offered therefore a sure infection court through which the mycelium entered.

This also shows that the healing has been going on for a long time from the margin of the wound. But the wound is so large, it is yet far from being healed. Had it later healed over, it could not, of course, save the tree from destruction because the wound parasite was already permanently established in the interior, or heart, wood. Thus the wound which gave entrance to the fungus mycelium also offers a place for its exit in the formation of the fruit body.

From the time the mycelium entered the trunk at this wound,



60.—*Polyporus borealis. Disintegration of wood.*

which must have been from 25 to 40 years ago, the mycelium gradually made its way into the heart, and from there grew downward into the roots and upward through the heart to the top of the tree. Its presence on the roots was determined by the occurrence of the fruit bodies from a few places on exposed parts of the large roots while external evidence of its having reached the top of the tree was shown by a number of dead limbs in the top, some of which had fallen. Evidence of its having reached the top was also found on cutting down the tree, and taking out sections at different points in the trunk. Here was found an abundance of mycelium and the heart wood was in an advanced stage of decay.

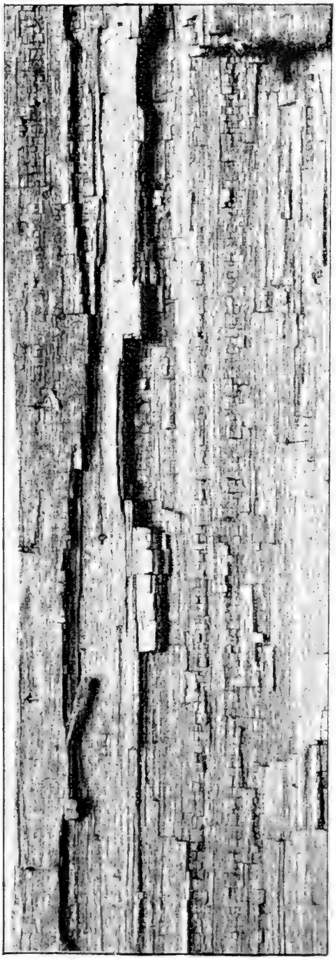
The mycelium advances in certain definite directions in the wood

of the tree. This is probably due to the structure of the wood. It grows in three different directions: parallel with the axis of the tree trunk, *i. e.*, up and down; radially, from the center toward the periphery; and tangentially. At one stage of development the mycelium may be very profuse and abundant. It then is present in the form of cords or strands which lie radially or tangentially in the channels which have been dissolved by the action of the fungus ferment on the wood. These strands lie quite close together and are parallel. After being developed in considerable abundance the strands of mycelium largely disappear having burrowed open channels and furrows through the wood in the radial and tangential directions.

61.—*Red spruce affected with Polyporus borealis.*

Shrinkage of the wood occurs at the same time because of the disappearance of a considerable content of the water and of the wood substance. This shrinking results in checking the wood into numerous minute cuboidal blocks, marked off primarily by the position, and solvent action of, the mycelium. This becomes more pronounced if the wood dries, if the tree is cut or if blocks of the wood are cut from the trunk and allowed to dry. In the early infection of the wood, and the early stages in the advance of the mycelium, before the larger strands have become established, the openings made by the mycelium are very minute. They take the same directions as the larger openings. In fact the mycelium, instead of making a general attack upon the tissues, begins its advance at certain regularly separated points, and then extends along in parallel lines. If the wood is cut out at this early stage, one can see these minute perforations thickly scattered over the exposed sur-

face. Sometimes, even in this early stage, shrinkage of the wood will have taken place. If not very marked when freshly cut from the wood, the shrinkage of the wood on drying, marks it off in a beautiful manner, by fine lines and holes into cuboideal areas.



62.— *Effect on wood of red spruce by the mycelium of Polyporus borealis.*

In many of these cases of the heart rot of trees, after the heart wood is well affected, the mycelium being well established and vigorous, gradually encroaches on the cambium or living area beneath the bark. In this way, many of the branches in the top of the tree die, and in some cases later the cambium of the trunk may be so destroyed as to kill the tree outright.

The red spruce example, in the Adirondack woods, was a tree of handsome proportions near Pearcefield Falls, in the Raquette River, left by the lumberman a few years prior to 1896, the season when I observed the tree. At some distance there was no indication that the tree was diseased and I enquired of my guide, who had at one time some experience in cutting timber, why the tree was left. "That tree ain't no good," he replied. As we approached nearer, he said, "don't you see the gum running from all the knot holes?" This he explained was regarded as a sure sign of "heart rot." Furthermore the tree was "checked" on one side, the crack being quite large and extending for some distance. The check was probably caused by a wrench given the weakened tree during a heavy wind. There was no other external

evidence that the tree was diseased, and to satisfy myself that the tree suffered from "heart rot," I had my guide cut out a few blocks of the wood from the trunk. Two inches beneath the bark the wood was found in a "dozed" condition. The heart was not in a very advanced stage of decay though the area was very extensive. The mycelium visible to the eye was very scanty. Still the wood showed numerous fine perforations, and as some shrinkage had taken place, it presented the very fine divisions into minute blocks

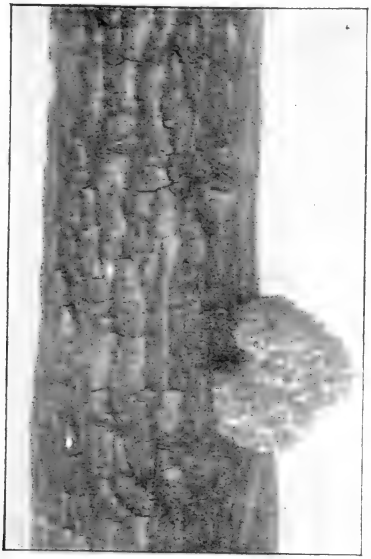
63.—*Fruit bodies of Polyporus borealis, showing shaggy cap.*

described above. I then searched more carefully for some fruit form of the fungus and found at the ground level, buried under leaves, a fruit body of the *Polyporus borealis* between two buttresses of the base of the trunk. The tree was not felled, and consequently there was no opportunity of ascertaining the special mode of infection in this case.

Polyporus Sulphureus.

The sulphur polyporus has a very wide distribution and occurs on a great variety of broad leaved trees as well as on certain of the

conifers. It is known on the apple, walnut, butternut, locust, oak, ash, pine, hemlock spruce, and other trees. It occurs on living trees, the fruit bodies growing from knot holes or wounds from the mycelium in the heart of the tree; or the fruit bodies arise from portions of the trunk killed by the fungus. It is also a very common fungus on dead and decaying logs, stumps and roots.



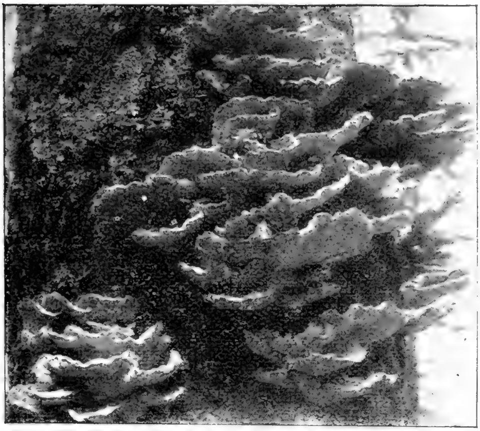
64.—*Polyporus sulphureus. Large tubercular fruit body on oak.*

The plant is easily recognized by the yellowish color of the caps which are of the shelving form, sometimes scattered, but more often closely over-lapping. Sometimes the caps are so closely crowded as to form a large tubercle 20 to 25 cm. or more in diameter. The upper surface of the cap is a bright orange red, while the lower surface, the honey-combed fruit surface, is sulphur yellow. The fruit bodies are rather soft, the color soon fades, they are quickly attacked by insects, or decay after several weeks. They are short lived therefore, while the mycelium within the trunk is perennial, or at least lives from year to year without an annual infection.

OAK TREE KILLED BY POLYPORUS SULPHUREUS.

A scarlet oak tree (*Quercus coccinea*) growing near the grounds of Cornell University was under observation for several years. The tree was standing on the edge of the Fall Creek gorge, not far from the Fisk McGraw mansion and opposite the present electric power plant of the Ithaca Street Railway. It was first observed in 1897. At this time the mycelium of the sulphur polyporus had advanced so far from the heart wood into the sap wood that the latter, as well as the cambium layer, on one side of the trunk near the base, had been killed. This gave an opportunity for the exit of the fungus, and the formation of the fruit bodies on the outside.

Fig. 65 is from a photograph taken in 1897. They are fine specimens, but are much more scattered than is usual with this species. The fruit bodies appeared during the succeeding seasons of 1898 and 1899. During the latter season the tree died from the injuries of the mycelium in its advance on the cambium or living portion of the trunk. It was felled, and several sections cut out from the trunk for observation.



65.— *Polyporus sulphureus. Scattered fruit bodies on living oak.*

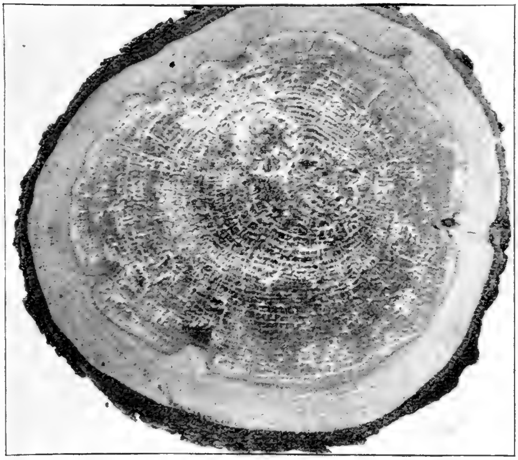
The decay of the heart wood had reached an advanced stage so that it was quite soft, and the moisture content was much less than in healthy trees. The lessening of the water content of the heart wood during the growth and spread of the mycelium caused a shrinkage in the wood. This produced several radial checks into which the mycelium had grown forming sheets of pure mycelium, sometimes called "punk."

66.— *"Punk" in cracks on oak log.*

POLYPORUS SULPHUREUS IMPRISONED IN A WHITE OAK.

A white oak tree about 40 years old was growing quite close by the side of a larger tree on the grounds of Cornell University. The tree leaned slightly away from the larger one and there was a one sided development of the branches induced by stronger illumination from that side.

The tree was felled in order to see if there was a corresponding asymmetry in the annual growth of the trunk which might be manifest in the excentric position of the annual rings. Before cutting the tree down there was no evidence that it was diseased. The trunk to all external appearance was sound. There were no broken limbs, no wounds, visible. On cutting the trunk into sections to study the annual rings, the heart wood through a large part of the trunk presented unmistakable evidences of partial decay following many of the annual rings and along by the medullary rays. The wood in these areas was being disorganized by the mycelium, and the latter forming the incipient stages of punk.



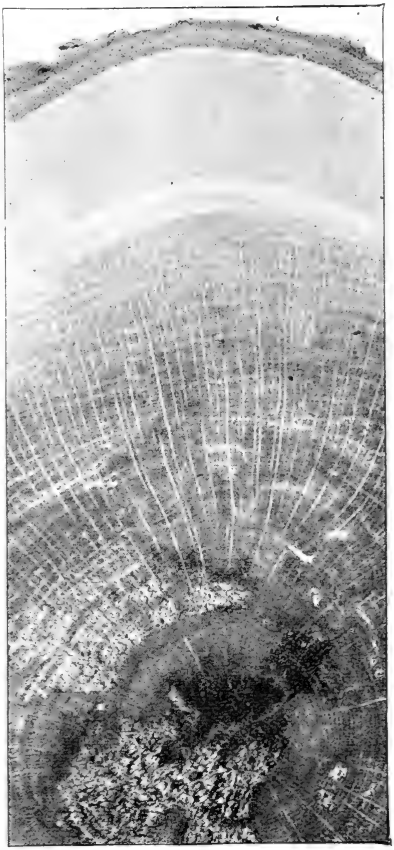
67.—*Section of living oak with imprisoned mycelium of the sulphur polyporus.*

The case was an interesting one since the question arose as to how the fungus, now completely imprisoned, gained entrance to the trunk. The butt was sound so the fungus could not have entered through the roots. Perhaps it entered at a large branch broken a number of years ago and now completely healed over.

All of the sections showed more or less decay at the central core of the heart wood where some of the wood was so badly decayed in some sections as to break out or crumble from the friction of the saw. One of the sections not far from the base of the trunk presented on the lower end, and near the periphery, a circular black area, resembling the dead remnant of a branch which might have broken off years ago, and healed over. On the surface of the same side of this section was a prominent enlargement in the trunk, resulting from the healing process. But the evidence

of a wound here was largely obliterated because the old bark had formed over the surface. There was only a minute opening, very obscure, which was not completely healed over.

By examining successive sections of the trunk below this one it was observed that this black "core" representing the broken portion of the young tree gradually came to lie exactly in the central core of the trunk. This indicates quite clearly that the injury occurred to the tree in the sapling stage, and that the sapling was broken off instead of one of the branches. One of the upper branches then became the "leader" and in course of time the broken end of the sapling was enclosed by the healing tissue.

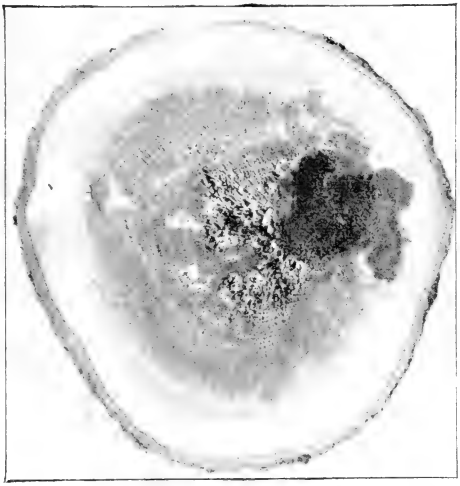


68.— *Section of oak showing decay at center.*

This section of the trunk was then sawed through lengthwise and in such a direction as to split the core of the dead sapling radially from the centre of the new trunk. A view of one-half of this section is shown in Fig. 70. It shows the origin of the branch which became the new "leader" of the tree as well as the large and irregular end of the broken sapling covered over by the healing tissue.

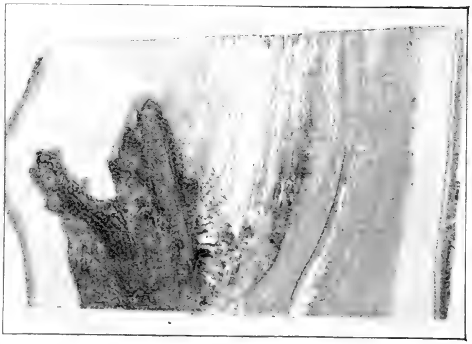
The cross section shows that this injury occurred more than 30 years ago, very near the time that Cornell University was founded. Some accident, the cause of which we cannot now determine, befell this tree in its youth and the sapling was broken off, while one of the topmost remaining branches in time replaced the main trunk.

An injury resulting from this kind of fractures leaves a long and slivered end some distance from the point where healing takes place. It must be a number of years then before the healing process can advance so far as to cover the fracture. In this instance over thirty years elapsed. The broken and slivered end of the sapling offered the most favorable lodgment place for spores of fungi, and for the accumulation of detritis resulting from the constant weathering of the exposed surface. In these places moisture is also conserved. The conditions presented are favorable for the germination of the spores and entrance of the mycelial threads. No more favorable infection court could be provided whereby the fungus is enabled to enter the heart wood.



69.—*Section of oak showing dead sapling stage near center.*

From this point of infection the mycelium spreads both ways down the old trunk of the sapling, and upward in the branch which forms the newly established leader. The progress of the fungus is comparatively slow, and the disorganization of the wood accompanies it. The slow growth of the mycelium is probably due to several causes, the resistance which it meets from the wood, the action of tannic acids in the heart wood, as well as to the



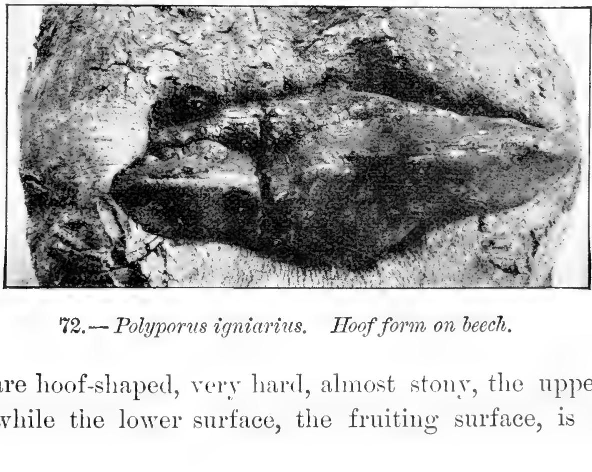
70.—*Section of oak showing slivered end of broken sapling.*

small amount of air in the interior of the tree. When sections of the trunk were cut, and piled together, the mycelium at the cut surfaces grew very rapidly. The mycelium here had access to air, and the moisture was conserved by the cut surfaces being in contact. In this way it was easy to demonstrate the presence of the mycelium in parts of the wood which to the eye appeared sound. The mycelium grew out from the wood into the moist air along the concentric annual rings, and the medullary rays, so that within 24 hours the location of the mycelium at these points was plainly demonstrated and photographs taken at this time marked the location of the mycelium in the infected areas. In several days' time, however, the mycelium spread out between the cut surface forming thin sheets of "punk."

71.—*Polyporus igniarius, tongue form of fruit body on beech.*

POLYPORUS IGNIARIUS.

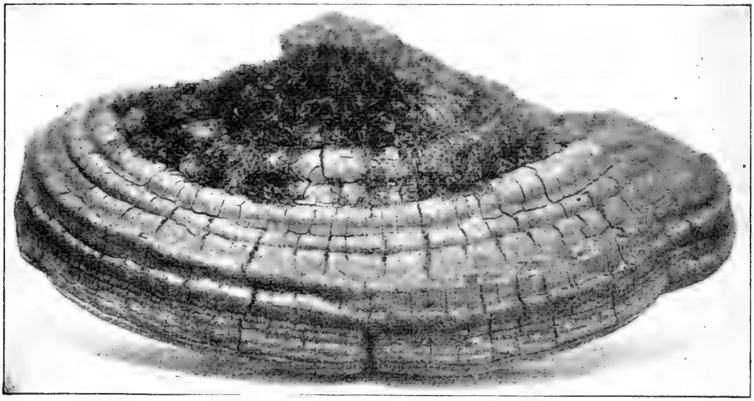
This species occurs on broad leaved trees. It is known on the apple, oak, alder, beech, birch, maple and other species. The fruit



72.—*Polyporus igniarius. Hoof form on beech.*

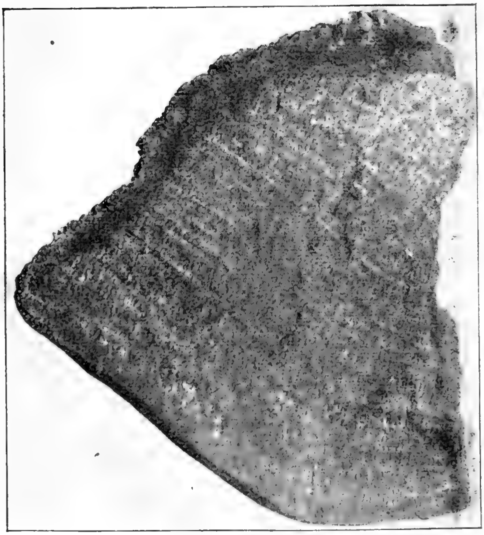
bodies are hoof-shaped, very hard, almost stony, the upper surface black, while the lower surface, the fruiting surface, is brownish.

The upper surface is marked by concentric furrows and ridges which mark off the annual layers. The fungus is thus perennial.



73.— *Polyporus igniarius, from maple.*

It is very generally distributed through hardwood forests. It is especially abundant in certain hardwoods in the Adirondacks. In some sections a large percentage of the beech, birch and maple is affected. A quantity of the wood of affected trees was collected both at Childwood, St. Lawrence Co., in 1896, and at Clearwater, Herkimer Co., in 1898. At the latter place, the second flag station north of Fulton Chain, on the N. Y. C. R. R., there were excellent opportunities for studying it on the maple, and for determining the conditions which favor the entrance of the fungus into the heart of the tree. Since the mycelium cannot enter through the living cambium of the tree, an "infection court" must



74.— *Section of fruit body of Polyporus igniarius.*

first be provided. These infection areas are provided in a variety of ways, in general their origin being the same as for other timber destroying fungi which enter through wounds.

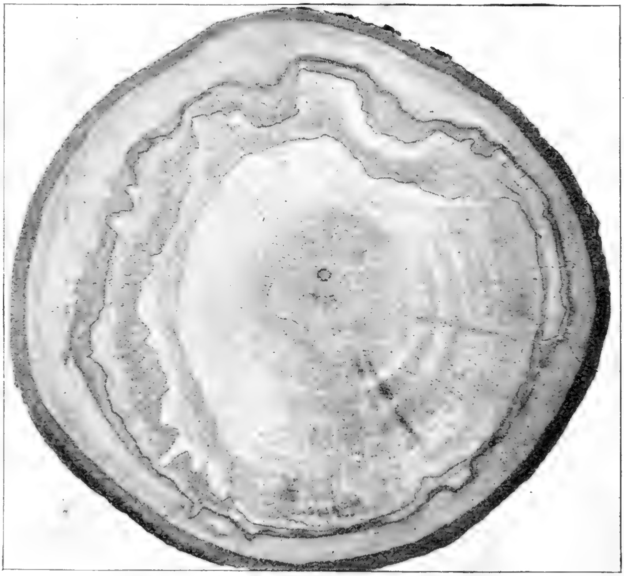
The conditions prevailing in a large portion of the mixed forests of the Adirondack region are such that a very common point for entrance is provided by the falling of the lower limbs. In the mixed forests the spruces and pines tower so far above the hardwood as to cut off much of the light. The hardwoods are thus so shaded that the area of foliage is considerably lessened, many of the trees having few limbs, and then bearing few leaves compared with trees in the open, or even in a hardwood forest where all the trees have an equal chance for light.

A maple tree about 20 cm. (eight inches) in diameter in the mixed forest at Clearwater had been affected by the *Polyporus igniarius* for a number of years. The fruit body was several years old, of a triangular shelving form, and 15 cm. broad. Several entire sections of the trunk, one of them bearing the fruit body of the fungus, were collected and shipped to Ithaca.

75.— *Section of maple tree showing effect of mycelium of Polyporus igniarius.*

Cross sections of the tree present a very characteristic and often beautiful marking of the wood due to the different stages of decay and the coloration of the wood. The more advanced stages of decay lie at the centre, the less advanced ones toward the periphery. The sound wood at the periphery is limited from the decayed area

toward the centre by a broad and irregular discolored area. The discolored area is of a light brown color, and this is farther sharply defined from the pale yellowish white area outlined by a narrow black line. The more advanced stages of decay in this maple tree advanced toward the periphery in separated columns, showing on cross section a radiating or digitate figure. The radiations or "fingers," alternate with dark areas which extend inward from the periphery as shown in the photograph. Sometimes this figure is quite regular around a portion of the margin, while other portions are very irregular. The decay of the wood seems to proceed in

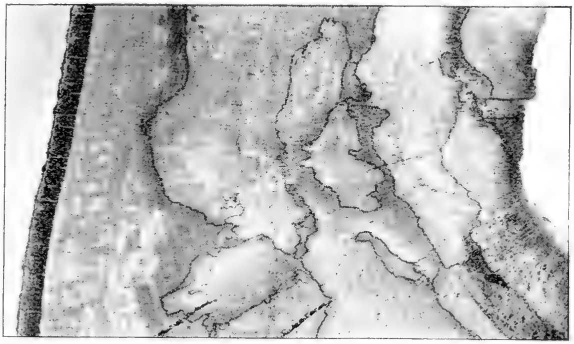


76.— *Young trunk of maple nearly killed by Polyporus igniarius.*

waves from the centre toward the periphery, so that there appear several different stages. The outer one is marked by the dark discolored area, the next is pale yellowish white, the wood being quite soft, and an older and more advanced area at the centre of the heart. These different stages in the process of decay from the centre to the periphery are usually limited by the black line, which is bordered by a more or less well defined corona of color darker than the area upon which it is advancing. In

many cases these areas of decay progress very irregularly, and the figure becomes complicated and confused, especially in the later stages of the decay of a tree, so that dark lines extend very irregularly.

An examination of several maple trees bearing the *Polyporus igniarius* gave evidence that the peculiar discoloration of the wood, accompanied the mycelium of this species of fungus, and might perhaps be sufficient to identify the species even where no fruit form of the fungus was present. An examination of the trunks of the beech bearing the *Polyporus igniarius* collected at Childwood, N. Y., in 1896, presented the same characteristic coloration and marking. The maple is said by some lumbermen to be troubled by a disease which they term "black heart." It would be interesting to know if the coloration produced in the heart by the action of the mycelium of *Polyporus igniarius* is identical with this "black heart" disease.



77.— *Effect of mycelium of Polyporus igniarius on wood of beech.*

It now becomes a mattter of interest to determine the mode of entrance of the mycelium of this fungus into the tree. The fruit bodies were found to be situated at wounds. These wounds, or places of exit for the fruit form of the fungus, were "knot" holes formed by the dying away of the lower limbs, and the failure of the healing tissue to close the wound thus formed. The fruit form can make its exit through quite a small opening, and usually does, growing to larger dimensions outside as it ages. The first year's

78.—*Ulcers on trunk of maple.*

growth of the fruit form may then be quite small, as in figure 79, where it is but a small protuberance, 1 to 2 cm. in diameter, and showing no fruiting surface. This often increases in size each year slowly until 4 to 5 cm. in diameter, when it may increase more rapidly and each year form a new fruiting surface beneath.

The young fruit form shown in the photograph is on a trunk of a maple 10 cm. in diameter. This was the only evidence that the tree was diseased, all the other wounds at fallen limbs having healed over. A section of the trunk shows that the heart rot had begun. It is in the first stages of the disease and confined to a limited area, that directly at the centre of the heart. There is present here only the discolored area which is characteristic of the other and younger area in older stages of the disease, described above. It is quite likely that the fungus enters at these slow healing wounds where the lower limbs have fallen, and that in some cases the wounds might entirely heal over and imprison the mycelium before the fruit bodies had an opportunity to form. That there was abundant opportunity for the mycelium of the fungus to enter at these wounds is shown by the evidence of a large proportion of the young maple trees in the mixed forest at Clearwater.

I have already called attention to the deep shade in the spruce woods where the tall spruces overtop the broad leaved trees, and of the effect which this shade has in checking foliage development on the younger maples. Even on the young and middle

aged maples there are comparatively few branches and these near the top of the tree, the lower branches having died and dropped off. The same can be said of the beeches, birches and other broad leaved trees. Even on these topmost branches there are comparatively few leaves, because of the low light reaction. This means then that a comparatively small amount of the carbohydrates necessary in the formation of cell walls and woody tissue is manufactured. Consequently growth and the formation of wood goes on slowly. This interferes in a striking way with the healing processes needed to cover up the wounds caused by the falling limbs.

When there is an abundance of foliage and light carbodydrates are formed in sufficient abundance to heal at a rapid rate. The healing tissue is firmer than the normal wood, and working from within and close to the branch, soon heals over and excludes the mycelium of the timber destroying fungi. On the other hand, when there are few leaves and a small amount of starch is formed the healing process goes on slowly, and before the opening caused by the falling limb can be closed, the portion of the branch exposed undergoes first weathering, and later the mycelium lays hold and enters, reaching the heart of the tree before the barrier of healing tissue is formed. From observations during several seasons it seems that this is a very common mode of entrance for the timber destroying fungi in the broad leaved trees.

79.—*Very young fruit body of Polyporus igniarius forming at a branch wound.*

A number of cases observed at Clearwater offer striking examples of the slowness with which the healing process goes on at branch wounds. The healing tissue formed slowly and did not close up against the base of the branch because of the small percentage of newly formed plant substance. Then for a series of years the heal-

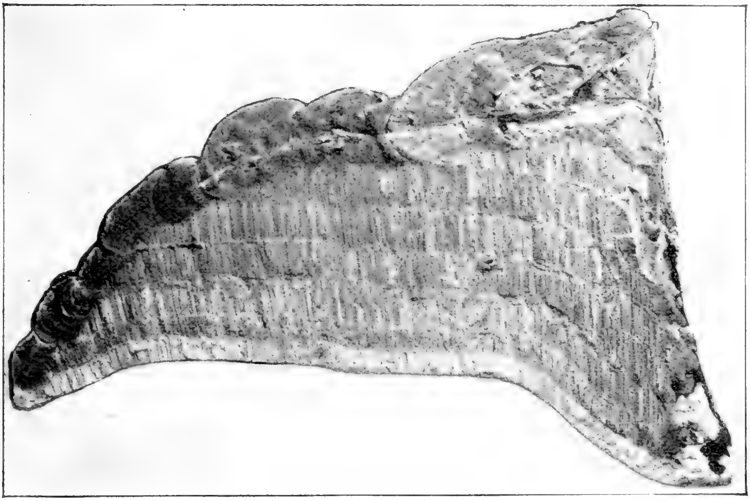
ing would cease and an area around the knot would die back. Then for another series of years the healing would begin and advance over a portion of this dead area, when another period would intervene during which a still greater area would die back. In this way large and ugly open ulcers are formed, in which the wood within is exposed. This condition is shown in photographs from young maples. On a number of these examples there were no fungus fruit bodies, but a section of the trunk shows all the character of the heart rot caused by the mycelium of *Polyporus igniarius*.

80.—*Fruit bodies of Polyporus pinicola on red spruce.*

The *Polyporus igniarius* has been known for a long time to inhabit fruit trees, especially the apple, peach, etc., under certain conditions. During August, 1900, I observed an apple tree by the roadside a few miles south of Cortland, N. Y., with fruit bodies of this polyporus on it. A number of years ago the tree had been pruned by cutting several large limbs near the trunk, and others out some distance from the trunk. The tree was probably diseased at that time, and perhaps these limbs were dead or dying. This may have led to their amputation.

In all cases the fruit bodies of the fungus were formed at these cut surfaces, there being no other place of exit. The tree was probably seriously wounded when young, and the mycelium entering had spread all through the heart of the trunk and branches, but was unable to form the fruit bodies until the larger limbs were pruned.

Several of the branches of this apple, bearing fruit bodies, were taken for examination. The character of the heart rot is in all essential respects the same as that observed in the maple and beech.



81.—*Section of fruit body of Polyporus pinicola, showing strata of tubes.*

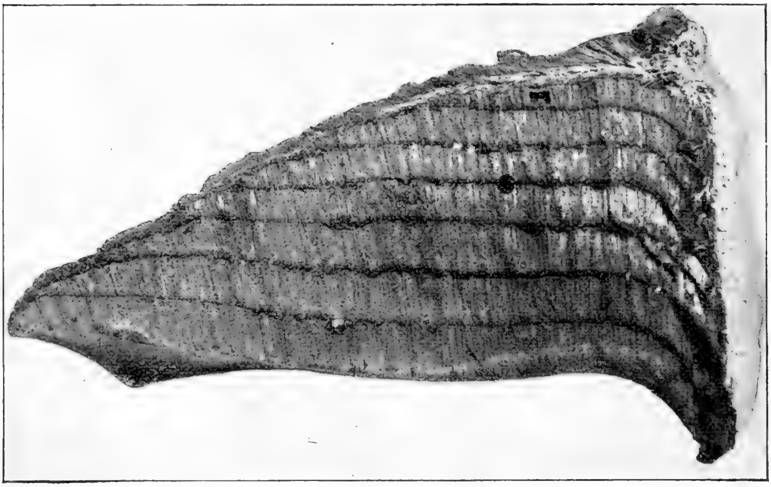
POLYPORUS PINICOLA.

The pine destroying polyporus is widely distributed in the United States and other north temperate regions. It occurs on various conifers, on the pines, spruces, balsams, larches, etc.

The fruit bodies are shelving, hard and firm, though not so hard as those of *Polyporus igniarius*. They are perennial and, therefore, single specimens increase in size from year to year, usually becoming broader below and of course thicker from each annual accretion layer.

The fruit body is marked on the upper surface by prominent con-

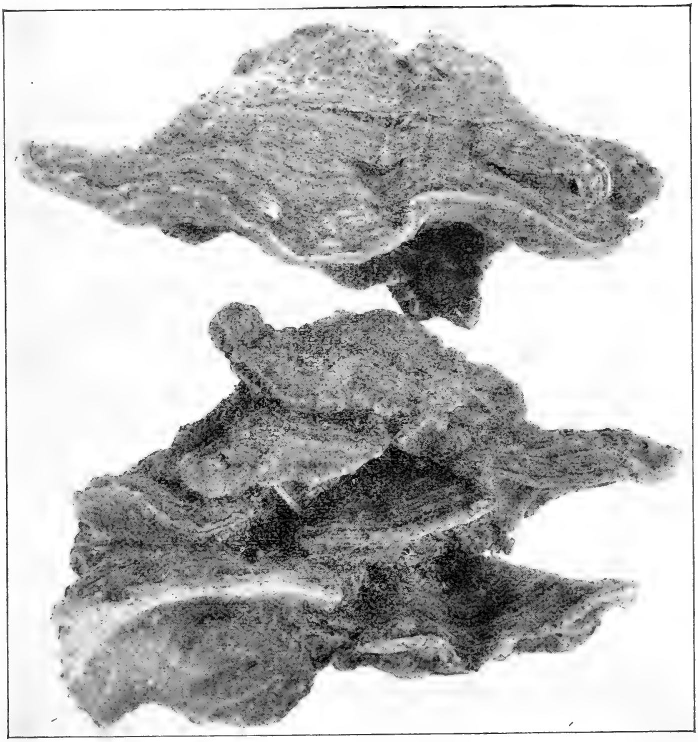
centric ridges and furrows. The marginal ridge is the one representing the latest year's growth. The color of the fruit body is from dark brown to nearly black at the base, varying to a reddish brown near the margin. The marginal zone representing the latest growth varies in color according to the time of collection. When the marginal zone is young it is whitish or yellowish in color, becoming reddish yellow or red later in the season and having then a shining polished surface. The under surface is yellowish white, and on bruising, the yellow color is often more distinct. The pores of the under surface are just visible to the naked eye. On sectioning the fruit body the annual layers seem quite distinct.



82.—*Section of fruit body of Polyporus applanatus, showing tube strata.*

The size and distinctness of these concentric elevations or zones on the upper surface of the fruit body vary according to the rapidity of growth. Where the growth is rapid the zones are large and prominent on the fruit body, increasing rapidly in size each year. One fine specimen collected on a hemlock spruce in the vicinity of Ithaca is 40 cm. broad by 25 cm. long, and is only six or eight years old, there being apparently two imperfect zones which may represent years of very slow and imperfect growth. Of the six annual

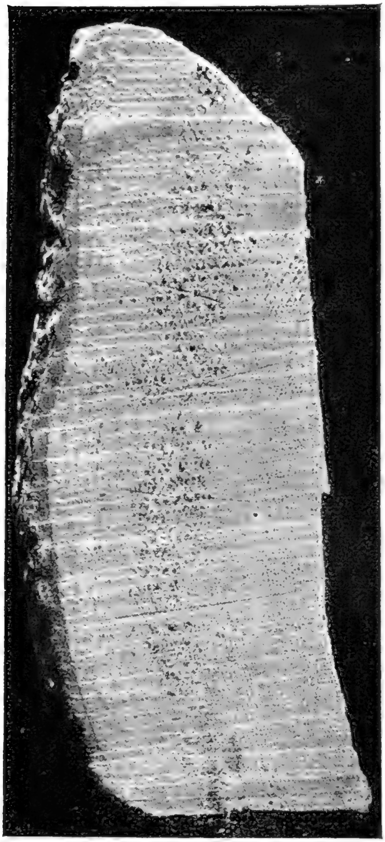
marginal accretions which are very prominent the measurements are as follows: First, 4 cm.; second, 6 cm.; third, 3 cm.; fourth, 2.5 cm.; fifth, 3.5 cm.; sixth, 4 cm. The usual size of the annual zone is from 2 to 3 cm. Sometimes, however, they are much smaller, from 4 to 8 mm., and then they are not very prominent. In such cases, however, the color character of the different zones and the character of the under surface make it possible to distinguish the plant from others.



83.—*Fruit bodies of Trametes abietis, shelving form.*

In this and some other forms where the zones are not very distinct it is occasionally difficult to separate the species from forms of *Polyporus applanatus*. In the latter species the tube surface is sometimes yellowish. In the fresh condition, if a bruise or scratch occurs on the tube surface of *Polyporus applanatus* the exposed

parts at once change to a dark brown or blackish color. When dry, however, this test will not yield the results desired, but section the plant through the middle perpendicularly and compare the color and structure of the tube strata. In *Polyporus applanatus* the strata are deeper and very clearly differentiated. They are also of a dark gray, or hair-brown color, while the tube strata of *Polyporus pinicola* are whitish or yellowish-brown, and while clearly differentiated are not so distinctly so as in *Polyporus applanatus.*



84.—"*Dozed" place in butt of red spruce from mycelium of Trametes abietis.*

The fruit bodies of *Polyporus pinicola* are sometimes found on the trunks of living trees, but much more frequently they do not appear until the tree is dead. They are quite common on dead standing trunks and stumps and on fallen logs. They continue to grow after the tree is dead and in quite an advanced stage of decay.

In wood which is in quite an advanced stage of decay extensive sheets of mycelium forming "punk" are often in the crevices formed by the checking of the wood. These sheets of punk are very similar to those formed by *Polyporus sulphureus* in deciduous as well as in coniferous trees. In the large number of cases in which I have found these sheets of punk in rotten logs or decaying tree trunks of conifers in the Adirondack mountains, I have not found any fruit bodies of the *Polyporus sulphureus.* Since these sheets of punk found in conifers are usually ascribed to this

species, I searched diligently for specimens on the trees. In no case in the Adirondacks have I yet found *Polyporus sulphureus* on conifers, although it probably does occur on them. This suggested that the sheets of punk in the conifers examined were connected with *Polyporus pinicola*, and many examples were studied in an endeavor to trace the connection of the sheets of punk in the trunk with the fruit bodies on the exterior.

85.— *Dead stub of red spruce where the mycelium entered.*

The direct connection was difficult to trace, although in most examples it was not difficult to trace the punk through the log radially to the bark, but at this point in splitting the bark radially the direct connection of the punk was not seen. The most favorable examples for study were those in which the fruit body was just originating as a tubercle 4 to 6 cm. in thickness on the outside of the bark. In splitting several of these from the tree a circular patch of the punk was found on the inner surface of the bark and looked very much as if the mycelium issuing from the tree and connected with the fruit body had been riveted on the inner surface of the bark, but on splitting such structures radially no evidence of the connection of the bark with the fruiting body was presented. However, on splitting the bark tangentially successive sheets of punk were found between the inner sheet and the fruit body. These sheets at certain points extended obliquely and connected so that they formed a zig-zag connection. The firm layers of the bark prevented the direct radial exit of the mycelium, but by working in a zig-zag fashion betwen the bark layers, it was enabled to make its exit. Having discovered this, it then became

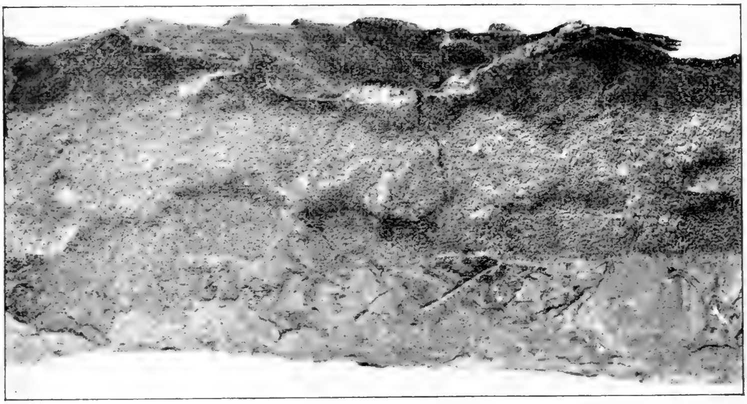
an easy matter to trace the connection of the punk in the log with the fruiting body in all cases.

POLYPORUS PINICOLA ON BROAD-LEAVED TREES.

I have not found any record of *Polyporus pinicola* on broad-leaved trees. I have, however, found it on three different species in the Adirondack mountains, on the beech (*Fagus ferruginea*), the birch (*Betula lenta*), and the maple (*Acer saccharum*).

TRAMETES ABIETIS.

This plant is common on spruces and balsams. It is a shelving form, and much smaller than the species of polyporus just described.



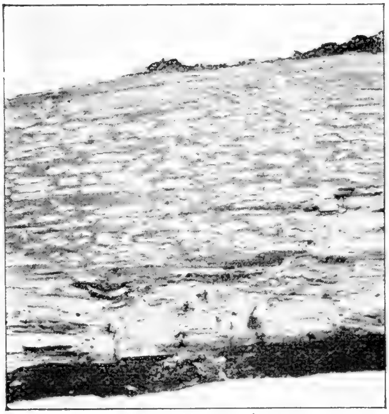
86.— *Fruit body of Trametes abietis spread out on surface of limb.*

The caps stand out from the wood 2 to 5 cm., are somewhat triangular in side view, and broader than long. The base is usually spread out where it is attached to the tree, and often the entire plant is spread over the surface of the wood. In this case no shelf form is developed. The upper surface of the shelf is marked by concentric furrows and ridges, and is more or less velvety or hairy. When young the fruit bodies are tawny in color, but in age they become a darker brown, especially above, while the fruiting surface is a yellowish brown.

TRAMETES ABIETIS ON THE RED SPRUCE.

An interesting example of a red spruce (*Picea rubra*) was examined during September, 1898, in the Adirondack mountains. This was near Nehasane, Herkimer Co., on the tract owned by Dr. Seward Webb. Through the courtesy of Prof. C. S. Graves, who then had the supervision of the forestry operations on this tract, I had the privilege of following the lumberman for two days to inspect trees, or portions of trees, which were discarded after they had been felled.

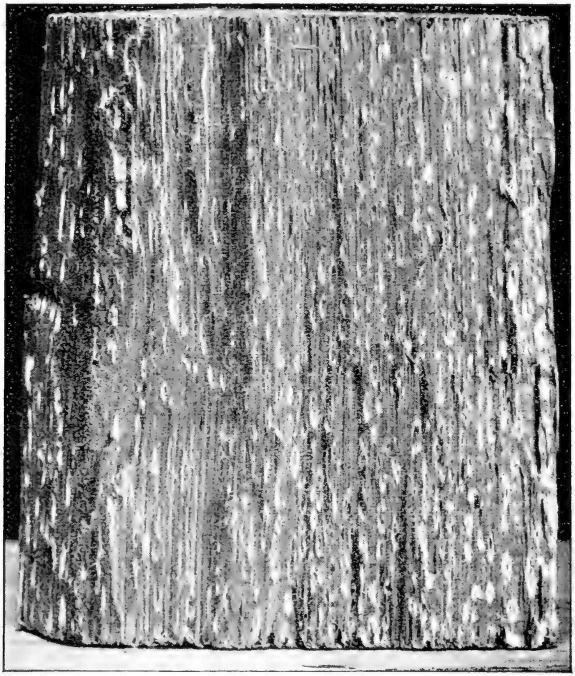
In this particular case the entire tree had been discarded, although two logs had been cut from the trunk. On approaching the tree I first came upon the stump, and searched here for some evidence of the reason for rejecting the timber. Near the periphery of the stump, in the older sap wood near its junction with the heart wood was a crescent shaped area in cross section about 3 cm. broad and 15 cm. long. This was distinctly marked off from the surrounding portion by the coarser fractures of the wood by the cross cut saw used in felling the tree. This indicated that the wood was here slightly "dozed." The remainder of the stump was sound. This small area showing such a slight alteration in the wood probably would not have been considered objectionable.



87.—*Pockets of decayed tissue in limb of red spruce.*

On examining the cut made for the first log, 16 feet above, the entire heart proved to be badly decayed. A large part of the sap wood was also invaded, and the cambium was being encroached upon. There remained only a thick shell of living and unaffected tissue underneath the bark. The heart wood was so soft that the fracture from the saw teeth was irregular, roughly cut and partially "ironed" down by friction from the saw blade. Still another log above this one had been cut off by the woodmen in the

hope that the heart would be sound, and that a good log could be obtained near the top. This cut, however, presented a condition similar to the first one, the heart and sap wood were badly decayed. This condition was sufficient to cause the abandonment of the entire tree. There were no evidences on the trunk, below the branches, of the fruit bodies of any fungus, nor of any injury which might have afforded an entrance for the fungus. The cut ends of timber were so badly roughed up by the saw that no structural characters



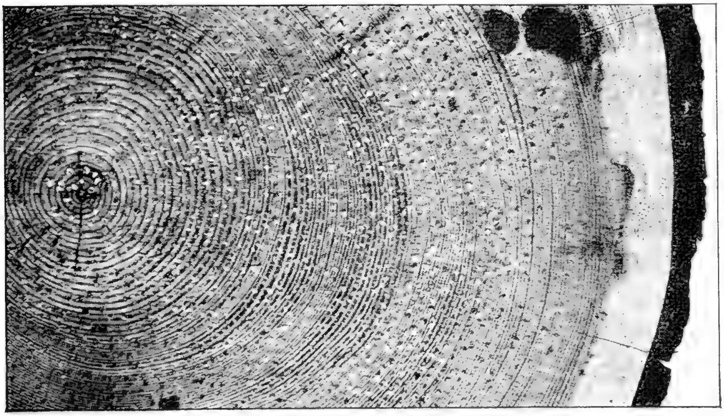
88.—*Pockets of decayed tissue in trunk of red spruce.*

in the diseased timber which might aid in the determination of the species of fungus could be seen. The next step was to determine the fungus and the place where it entered the tree.

Since the decay at the stump was so slight, and the diseased area so small in comparison with the extensive injuries farther up in the trunk it was quite evident the fungus had not entered from below. Upon searching in the top of the fallen tree, it was found that the

"leader" of the tree when about 5 cm. (2 inches) in diameter had been broken off, possibly by a falling tree, 30 or 40 years ago. This leader, as a dead, decorticated object still projected 15 to 20 cm. above the point where the healing process was going on (Fig. 85). One of the upper branches at this point had become the leader.

This old fracture of the main trunk years ago very probably provided an opportunity for the entrance of the fungus. Most conifers are provided with a quantity of free resin in the young branches or shoots, or the growing portion of the trunk. As is well known this resin flows freely from fresh wounds, and often continues for some time from old ones. The presence of this resin and its free exudation from wounds is nature's most effective method of blocking the way to the entrance of timber destroying fungi in the conifers.

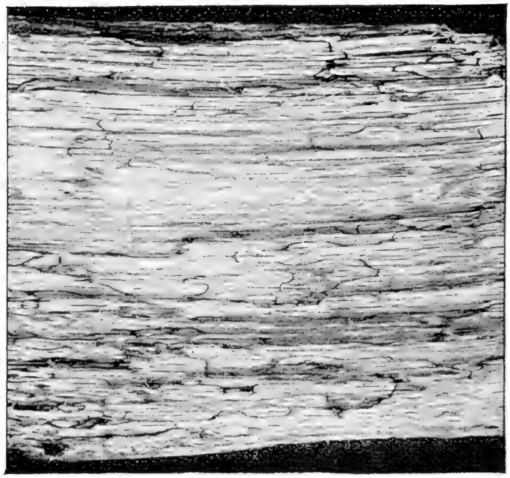


89.—*Cross section of red spruce showing pockets from end view.*

When the wound is small, or the broken branch or shoot is young, the amount of resin forms an effectual barrier against the entrance of this class of fungi. Where the wound is larger, or the shoot is older, the process of healing over requires many years, and the older portions of the wood do not yield so great an amount of free resin.

The brooken shoot in this example was 5 cm. (2 inches) in diameter. Healing began 20 to 30 cm. below the broken end. After 30

or 40 years the dead prong still projected 15 to 20 cm. above the healing surface, and probably never would have healed over. During this long time the fungus mycelium had an opportunity to enter, travel down the heart wood of the trunk and reach the butt. It is interesting to observe that while the fungus mycelium gained entrance through the broken area of the leader in the top of the tree, and traveled downward, the greater injury to the trunk was some distance below. This is probably due to the greater amount of free resin in the younger portion of the trunk above. While the mycelium traveled downward through this, it did not spread rapidly here nor bring about such a complete disintegration of the tissue. Sections of the trunk just below the point where the fungus entered, and for some distance below, show the heart wood is finer and harder though invaded by the mycelium. The wood is also very much stained, brown irregular areas often marked off by black lines, or divided up into smaller areas by black lines. The mycelium also traveled upward in the newly established leader of the tree. From the trunk it had invaded many of the branches in the same way. As is usual in such cases a number of the branches had been killed. These dead branches then yielded readily to the disintegrating action of the fungus.



90.— *Rotten section from rotted log of red spruce.*

On a few of the limbs fruit bodies of *Trametes abietis* were found. A branch bearing a fruit body and broken at this point shows the gross structural characters of the wood affected by the mycelium of this species. This is shown in the photograph. At one stage in the decay of the wood there are numerous areas in

which the process of disintegration is localized, or where it proceeds much more rapidly than in the surrounding wood. These isolated centres are quite evenly distributed. The wood is broken down completely, and largely consumed, leaving a partial skeleton, or nearly all of it having disappeared. The remnant, as well as a thin layer of the bordering tissue, is bleached and white. It is thus in strong contrast with the reddish color of the surrounding wood where the decay has been checked or has proceeded more slowly. This rapid local disintegration, then, forms numerous small "pockets" distributed through the affected wood at a certain stage in the progress of the disease. They are plainly visible because of the bleached tissue.

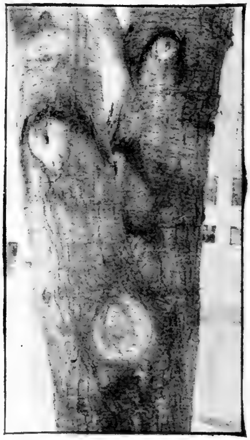
91.—*Badly pruned oak tree.*

These pockets are a characteristic feature in one stage of the heart rot of the spruce from the mycelium of *Trametes abietis.* If they are found in the heart wood of the trunk of this individual spruce it would be quite conclusive evidence that the heart rot here was caused by this fungus, and that the infection having occurred at the broken trunk in the top of the tree many years ago had gradually spread down the trunk to the base and out into numerous branches, some of which have been killed as a result. Sections of the trunk of this tree were cut out at different places and shipped to Ithaca for study.

On splitting sections of the trunk cut from the discarded logs, these characteristic pockets were found to be present, and Fig. 88 is from a photograph of a small block. These occur in the portions of the trunk where decay has made considerable progress, the entire heart being invaded, and the fungus encroaching on the "sap" wood. When cut with the cross-cut saw, or even with a finer saw, the ends of the blocks do

not show the pockets, since the soft wood is so readily fractured by the teeth of the saw. But when the end of a block is planed off smooth the pockets in transection are quite distinctly brought to view. They are shown in the photograph. From a side and end view shown in the photographs the pockets are seen to be oblong in side view and cylindrical in cross section. They are 2 to 3 mm. broad and 4 to 6 mm. long. In the younger portions of the trunk, some distance above the size where logs were cut, and below the point of entrance of the fungus, and thus nearer it, the pockets were not yet formed. This is probably due to the fact that while the mycelium first penetrated the heart wood here, the latter being younger was more resistant, and the process of disintegration proceeded less rapidly. The pockets appearing on certain of the branches is accounted for by the fact that these branches had been killed for some time, and were consequently in a less resistant condition.

92.—*Result of bad pruning of hickory, the limbs have rotted out allowing entrance of fungus mycelium.*



93.—*Proper way to prune, wounds healing up properly.*

The formation of pockets by the rapid disintegration of the tissues at many centres recalls the "peckiness" of cypress wood caused by the mycelium of a fungus yet unknown. The pockets in the cypress wood are much larger, however, and the structural character of the affected wood is quite different. In the case of the cypress trunks affected with this disease known as "peckiness," it is believed that the fungus, while developing at the centres, excretes an enzyme or "ferment," which permeates the surrounding wood and acts as an antiseptic which prevents the further

disintegration. It is possible that this is to some extent the case in the formation of the pockets in the spruce timber, that is, that the wood intervening between the centres of rapid disintegration, becomes permeated with an enzyme excreted by the mycelium which renders it immune for a time, or at least retards the disintegration of the wood. But if this is the case, the effect of the antiseptic is not lasting. In the case of fallen logs affected by the *Trametes abietis* the decay continues until all parts of the wood are in a much decayed condition. Still, in such logs, it is quite evident that the progress of the disintegration has been intermittent, certain centres having first decayed, and in time spreading from these pockets to surrounding areas until all the wood is brought under complete contribution to the mycelium. In such decayed spruce wood, there are further evidences that the decay has spread from numerous centres which have been extended until they finally met. This is shown in the varying coloration of the wood, and especially by black boundary or limiting lines. (Fig. 90.)

94.—*Shade tree used as a hitching post.*

It is evident from these and similar studies that there is no cure for the diseases caused by wound parasites after once the fungus has entered through the wound into the interior of the tree. For a few years there may be no apparent injury but with the lapse of time the tree becomes badly injured if not destroyed. The trees may live for years, or even a century or more with the fungus inside still growing. They may be so weakened that they are broken down or uprooted during strong winds. Shade trees may be rendered unsightly, and lacking in density of foliage. Fruit trees may be rendered less fruitful if not ultimately killed. Timber trees in a very few years may be so injured as to be worthless for the market.

In their relation to forestry these studies emphasize the desira-

bility of careful and economical methods in the felling of timber to protect the young stand from injury, in the supply of light to the forest floor, and in the protection from fire. For while many forest fires may not be so severe as to kill the trees outright the fire often scorches exposed roots, or the base of the trunks, where the leaves are thick, or by a dead and dry log or stump, thus affording an entrance for these wound parasites.

In the handling of fruit and shade trees there should be the greatest care from the nursery stock to the fruiting tree to prevent wounds. In pruning operations especially should there be care in pruning smooth and close to the trunk, followed by the use of some antiseptic wash, or lead paint.

The Following Bulletins are Available for Distribution to Persons Living in New York State.

40 Removing Tassels from Corn, 9 pp.
71 Apricot Growing in Western New York, 26 pp.
72 The Cultivation of Orchards, 22 pp.
74 Impressions of the Peach Industry in N. Y., 28 pp.
76 Some Grape Troubles in Western N. Y., 116 pp.
79 Varieties of Strawberry Leaf Blight, 26 pp.
80 The Quince in Western N. Y., 27 pp.
87 Dwarf Lima Beans, 24 pp.
93 Cigar-Case-Bearer, 20 pp.
97 Entomogenous Fungi, 42 pp.
101 The Spraying of Trees and the Canker Worm, 24 pp.
102 General Observations in Care of Fruit Trees, 26 pp.
103 Soil Depletion in Respect to the Care of Fruit Trees, 21 pp.
109 Geological History of the Chautauqua Grape Belt, 36 pp.
110 Extension Work in Horticulture, 42 pp.
114 Spraying Calendar.
116 Dwarf Apples, 31 pp.
117 Fruit Brevities, 50 pp.
119 Texture of the Soil, 8 pp.
120 Moisture of the Soil and Its Conservation, 24 pp.
121 Suggestions for Planting Shrubbery.
122 Second Report upon Extension Work in Horticulture, 36 pp.
123 Green Fruit Worms, 17 pp.
124 The Pistol-Case-Bearer in Western New York, 18 pp.
126 The Currant Stem Girdler and the Raspberry-Cane Maggot, 22 pp.
129 How to Conduct Field Experiments with Fertilizers, 11 pp.
130 Potato Culture, 15 pp.
131 Notes upon Plumbs for Western New York, 31 pp.
134 Strawberries under Glass, 10 pp.
135 Forage Crops, 28 pp.
136 Chrysanthemums, 24 pp.
137 Agricultural Extension Work, Sketch of its Origin and Progress, 11 pp
138 Studies and Illustrations of Mushrooms; I, 32 pp.
139 Third Report upon Japanese Plums, 16 pp.
140 Second Report on Potato Culture, 24 pp.
141 Powdered Soap as a Cause of Death Among Swill-Fed Hogs.
142 The Codling-Moth.
143 Suger Beet Investigations, 88 pp.
144 Suggestions on Spraying and on the San Josè Scale.
145 Some Important Pear Diseases.
146 Fourth Report of Progress on Extension Work, 26 pp.
147 Fourth Report upon Chrysanthemums, 36 pp.
148 Quince Curculio, 26 pp.
149 Some Spraying Mixtures.
150 Tuberculosis in Cattle and Its Control.
151 Gravity or Dilution Separators.
152 Studies in Milk Secretion.
153 Impressions of Fruit-Growing Industries.
154 Table for Computing Rations for Farm Animals.
155 Second Report on the San Josè Scale.
156 Third Report on Potato Culture.
157 Grape-vine Flee-beetle.
158 Source of Gas and Taint Producing Bacteria in Cheese Curd.
159 An Effort to Help the Farmer.
160 Hints on Rural School Grounds.
161 Annual Flowers.
162 The Period of Gestation in Cows.
163 Three Important Fungous Diseases of the Sugar Beet.
164 Peach Leaf-Curl.
165 Ropiness in Milk and Cream.
166 Sugar Beet Investigations for 1898.
167 The Construction of the Stave Silo.
168 Studies and Illustrations of Mushrooms: II.
169 Studies in Milk Secretion.
170 Tent Caterpillars.
171 Concerning Patents on Gravity or Dilution Separators.
172 The Cherry Fruit-Fly: A New Cherry Pest.
173 The Relation of Food to Milk-Fat.
174 The Problem of Impoverished Lands.
175 Fourth Report on Japanese Plums.
176 The Peach-Tree Borer.
177 Spraying Notes.
178 The Invasion of the Udder by Bacteria.
179 Field Experiments with Fertilizers.
180 The Prevention of Peach-Leaf Curl.
181 Pollination in Orchards.
182 Sugar Beet Investigations for 1899.

Bulletins Issued Since the Close of the Fiscal Year, June 30, 1900.

183 Sugar Beet Pulp as a Food for Cows.
184 The Grape Root-Worm; New Grape Pest in New York.
185 The Common European Praying Mantis; A New Beneficial Insect in America.
186 The Sterile Fungus Rhizoctonia.
187 The Palmer-Worm.
188 Spray Calendar.
189 Oswego Strawberries.
190 Three Unusual Strawberry Pests and a Greenhouse Pest.
191 Tillage Experiments with Potatoes.
192 Further Experiments against the Peach Tree Borer.
193 Shade Tree and Timber Destroying Fungi.

APPENDIX II.

Detailed Statement of Receipts and Expenditures of the Cornell University Agricultural Experiment Station, for the fiscal year ending June 30, 1901.

EXPENDITURES.

FOR SALARIES.

1900.			
July	30.	I. P. Roberts, Director	$125 00
"	30.	L. H. Bailey, Horticulturist	125 00
"	30.	H. H. Wing, Dairy Husbandry	125 00
"	30.	M. V. Slingerland, Assistant Entomologist	135 00
"	30.	G. F. Atkinson, Botanist	83 33
"	30.	G. W. Cavanaugh, Assistant Chemist	108 33
"	30.	L. A. Clinton, Assistant Agriculturist	100 00
"	30.	E. A. Butler, Clerk	65 00
"	30.	L. V. Maloney, Stenographer	49 50
Aug.	31.	I P. Roberts, Director	125 00
"	31.	L. H. Bailey, Horticulturist	125 00
"	31.	H. H. Wing, Dairy Husbandry	125 00
"	31.	M. V. Slingerland, Assistant Entomologist	135 00
"	31.	G. F. Atkinson, Botanist	83 33
"	31.	G. W. Cavanaugh, Assistant Chemist	108 33
"	31.	L A. Clinton, Assistant Agriculturist	100 00
"	31.	E. A. Butler, Clerk	65 00
"	31.	L. V. Maloney, Stenographer	49 50
Sept.	29.	I. P. Roberts, Director	125 00
"	29.	L. H. Bailey, Horticulturist	125 00
"	29.	H. H. Wing, Dairy Husbandry	125 00
"	29.	M. V. Slingerland, Assistant Entomologist	135 00
"	29.	G. F. Atkinson, Botanist	83 33
"	29.	G. W. Cavanaugh Assistant Chemist	108 33
"	29.	L. A. Clinton, Assistant Agriculturist	100 00
"	29.	E. A. Butler Clerk	65 00
"	29.	L. V. Maloney, Stenographer	47 67
		Amount carried forward	$2,746 65

1900.		Amount brought forward	$2,746 65
Oct.	31.	I. P. Roberts, Director	125 00
"	31.	L. H. Bailey, Horticulturist	125 00
"	31.	H. H. Wing, Dairy Husbandry	125 00
"	31.	M. V. Slingerland, Assistant Entomologist	135 00
"	31.	G. F. Atkinson, Botanist	83 33
"	31.	G. W. Cavanaugh, Assistant Chemist	108 33
"	31.	L. A. Clinton, Assistant Agriculturist	100 00
"	31.	E. A. Butler, Clerk	65 00
"	31.	L. V. Maloney, Stenographer	49 50
Nov.	30.	I. P. Roberts, Director	125 00
"	30.	L. H. Bailey, Horticulturist	125 00
"	30.	H. H. Wing, Dairy Husbandry	125 00
"	30.	M. V. Slingerland, Assistant Entomologist	135 00
"	30.	G. F. Atkinson, Botanist	83 33
"	30.	G. W. Cavanaugh, Assistant Chemist	108 33
"	30.	L. A. Clinton, Assistant Agriculturist	100 00
"	30.	E. A. Butler, Clerk	65 00
"	30.	L. V. Maloney, Stenographer	47 66
Dec.	31.	I. P. Roberts, Director	125 00
"	31.	L. H. Bailey, Horticulturist	125 00
"	31.	H. H. Wing, Dairy Husbandry	125 00
"	31.	M. V. Slingerland, Assistant Entomologist	135 00
"	31.	G. F. Atkinson, Botanist	83 33
"	31.	G. W. Cavanaugh, Assistant Chemist	108 33
"	31.	L. A. Clinton, Assistant Agriculturist	100 00
"	31.	E. A. Butler, Clerk	65 00
"	31.	L. V. Maloney, Stenographer	49 50
1901.			
Jan.	31.	I. P. Roberts, Director	125 00
"	31.	L. H. Bailey, Horticulturist	125 00
"	31.	H. H. Wing, Dairy Husbandry	125 00
"	31.	G. F. Atkinson, Botanist	83 33
"	31.	L. A. Clinton, Assistant Agriculturist	100 00
"	31.	L. V. Maloney, Stenographer	49 50
Feb.	28.	I. P. Roberts, Director	125 00
"	28.	L. H. Bailey, Horticulturist	125 00
"	28.	H. H. Wing, Dairy Husbandry	125 00
"	28.	G. F. Atkinson, Botanist	83 33
"	28.	L. A. Clinton, Assistant Agriculturist	100 00
"	28.	L. V. Maloney, Stenographer	44 00
Mar.	30.	I. P. Roberts, Director	125 00
"	30.	L. H. Bailey, Horticulturist	125 00
		Amount carried forward	$6,953 45

1900.	Amount brought forward	$6,953 45
Mar. 30.	H. H. Wing, Dairy Husbandry	125 00
" 30.	G. F. Atkinson, Botanist	83 33
" 30.	L. A. Clinton, Assistant Agriculturist	100 00
Apr. 29.	I. P. Roberts, Director	125 00
" 29.	L. H. Bailey, Horticulturist	125 00
" 29.	H. H. Wing, Dairy Husbandry	125 00
" 29.	G. F. Atkinson, Botanist	83 33
" 29.	L. A. Clinton, Assistant Agriculturist	100 00
May 29.	I. P. Roberts, Director	125 00
" 29.	L. H. Bailey, Horticulturist	125 00
" 29.	H. H. Wing, Dairy Husbandry	125 00
" 29.	G. F. Atkinson, Botanist	83 33
" 29.	L. A. Clinton, Assistant Agriculturist	100 00
June 29.	I. P. Roberts, Director	125 00
" 29.	L. H. Bailey, Horticulturist	125 00
" 29.	H. H. Wing, Dairy Husbandry	125 00
" 29.	G. F. Atkinson, Botanist	83 33
" 29.	L. A. Clinton, Assistant Agriculturist	100 00
	Total for salaries	$8,936 77

FOR OFFICE AND PRINTING.

1900.		
July 5.	Expressage	$ 35
" 10.	M. A. Adsitt, letter paper	2 00
" 10.	Cornell Coöperative Society, office supplies	1 95
" 12.	Ithaca Gas Co., gas	1 25
" 12.	Postage	25 00
" 12.	Andrus & Church, report blanks	3 50
" 30.	H. W. Butler, labor	23 75
Aug. 3.	Ithaca Gas Co., gas	88
" 3.	Postage	40 00
" 3.	Cornell Coöp. Society, pencils	25
" 3.	Empire State House Furnishing Co., repairs	75
" 3.	Cornell Coöp. Society, photo supplies	3 10
" 31.	H. W. Butler, labor	8 55
Sept. 8.	W. F. Humphrey, Annual Report	92 80
" 15.	Postage	25 00
" 17.	Ithaca Gas Co., gas	63
" 24.	E. A. Butler, traveling expenses	3 60
" 28.	Felt & Tarrant, repairs on comptometer	13 75
Oct. 1.	H. W. Butler, labor	16 50
	Amount carried forward	$263 61

1900.		Amount brought forward	$263 61
Oct.	5.	Cornell Coöp. Society, office supplies	7 63
"	6.	Expressage	1 50
"	17.	Freight and cartage	6 61
"	18.	F. E. Illston, ice	1 83
"	23.	Ithaca Gas Co., gas	25
"	27.	Orange Judd Co., 3 books	3 00
"	30.	Andrus & Church, observation books	7 00
"	31.	G. W. Tailby, labor	9 05
"	31.	H. W. Butler, labor	14 40
Nov.	2.	Cornell Coöp. Society, pens and pencils	84
"	15.	C. M. Cooper & Co., half tones	5 00
"	15.	Ithaca Gas Co., gas	1 03
"	27.	I. P. Roberts, traveling expenses	34 05
"	30.	H. W. Butler, labor	4 40
Dec.	3.	W. F. Humphrey, printing	70 20
"	3.	Cornell Coöp. Society, office supplies	4 65
"	3.	C. J. R. & Co., sundries	4 85
"	3.	L. A. Clinton, traveling expenses	2 64
"	3.	I. P. Roberts, traveling expenses	8 00
"	10.	M. A. Adsitt, paper and printing	9 85
"	10.	Ithaca Gas Co., gas	75
"	10.	W. F. Humphrey, printing and envelopes	18 84
"	11.	Expressage	25
"	14.	G. P. Rowell & Co., newspaper directory	5 00
"	17.	W. F. Humphrey, insurance on mailing list	15 00
"	22.	M. A. Adsitt, stationery and repairs	4 40
"	31.	G. W. Tailby, labor	9 10
"	31.	H. W. Butler, labor	1 60
1901.			
Jan.	3.	Membership fee in A. A. A. C. & E. S.	10 00
"	3.	Andrus & Church, record book	4 12
"	10.	Cornell Coöp. Society, mimeograph work	3 98
"	10.	Ithaca Gas Co., gas	1 63
"	10.	E. A. Butler, traveling expenses	3 10
"	31.	Freight and cartage	7 72
"	31.	G. W. Tailby, labor	11 25
"	31.	H. W. Butler, labor	3 00
Feb.	11.	E. D. Norton, postals and printing	11 50
"	11.	Postage	20 00
"	11.	Ithaca Gas Co., gas	1 00
"	14.	Cornell Coöp. Society, office supplies	2 34
		Amount carried forward	$594 97

1900.		Amount brought forward	$594 97
Feb.	14.	T. G. Miller, envelopes and printing	38 72
"	14.	W. F. Humphrey, envelopes and printing	24 64
"	14.	Freight and cartage	10 14
"	21.	W. F. Humphrey, Bulletin No. 186	284 80
"	26.	E. A. Butler, traveling expenses	3 70
"	27.	C. C. Smith, shipping tags.	1 75
"	27.	E. D. Norton, postals and printing	11 50
Mar.	2.	M. A. Adsitt, stationery	3 40
"	4.	Postage	50 00
"	9.	Cornell Coöp. Society, office supplies	2 40
"	11.	Ithaca Gas Co., gas	1 25
"	11.	Felt & Tarrant, repairs on comptometer	5 08
"	19.	Andrus & Church, postals and printing	6 25
"	29.	Expressage	1 35
"	30.	G. W. Tailby, labor	4 40
"	30.	H. W. Butler, labor	9 20
Apr.	2.	Telephone company, messages	1 00
"	5.	H. B. Winters, traveling expenses	11 03
"	8.	Cornell Coöp. Society, office supplies	5 41
"	12.	Freight and cartage	4 78
"	12.	S. C. Hulse, labor	3 50
"	17.	W. F. Humphrey, printing Bulletin No. 188	130 00
"	23.	Gas	1 38
"	30.	H. W. Butler, labor	35 80
"	30.	G. W. Tailby, labor	3 60
May	7.	Postage	21 00
"	8.	T. G. Miller, stationery	75
"	8.	Cornell Coöp. Society, office supplies	3 52
"	11.	Expressage	30
"	17.	Gas	75
"	31.	H. W. Butler, labor	37 60
"	31.	G. W. Tailby, labor	1 80
June	1.	Cornell Coöp. Society, office supplies	13 98
"	6.	Austin Engraving Company, half tones	67 00
"	6.	Freight and cartage	4 35
"	6.	Postage	31 00
"	14.	W. F. Humphrey, Bulletin No. 190	365 60
"	14.	C. J. Rumsey & Co., shelf plates	63
"	18.	Andrus & Church, pads	50
"	18.	C. M. Cooper & Co., electros	1 25
"	22.	Expressage	1 60
		Amount carried forward	$1,801 68

1900.	Amount brought forward	$1,801 68
June 22.	Expressage	55
" 24.	T. G. Miller, ledger	6 75
" 24.	T. G. Miller, stationery and printing	49 00
" 24.	Gas	88
" 28.	W. F. Humphrey, Bulletin No. 193	403 10
	Total for office and printing	$2,261 96

FOR AGRICULTURAL DIVISION.

1900.		
July 5.	Expressage	$2 55
" 11.	Labor	5 00
" 13.	Expressage	1 40
" 24.	Labor	4 50
" 28.	Expressage	50
" 31.	Labor	44 15
Aug. 9.	Butter report blanks	3 50
" 9.	Grass seed	30
" 9.	Curtains	80
" 15.	Photo plates	23 76
" 31.	Labor	38 09
Sept. 4.	Day book	2 50
" 7.	Expressage	5 65
" 10.	Food record books	4 50
" 17.	Drugs	2 40
" 17.	Gum labels	75
" 24.	Telegraph Co.	26
Oct. 1.	Labor	41 13
" 2.	Pigs	19 50
" 5.	Pails and covers	4 50
" 17.	Milk testing	5 00
" 31.	Labor	45 42
Nov. 7.	Photo supplies	2 60
" 20.	Expressage	95
Dec. 1.	Labor	11 70
" 19.	Lumber	1 19
" 31.	Labor	64 60
1901.		
Jan. 3.	Repairs on dynamometer	1 00
" 28.	Expressage	35
" 31.	Labor	27 60
Feb. 1.	Telegrams	55
	Amount carried forward	$366 50

1901.		Amount brought forward	$366 50
Feb.	9.	Expressage	2 30
"	11.	Sundry supplies	85
"	11.	Postage	21 20
"	11.	Repairs on separators	2 00
"	14.	Expressage	1 35
"	28.	Labor	27 14
Mar.	2.	Publications	9 01
"	11.	Expressage	70
"	25.	Barley	1 01
"	29.	Expressage	1 65
Apr.	4.	Freight and cartage	2 14
"	17.	Beans	1 60
"	17.	Peas	78
"	23.	Freight and cartage	77
May	9.	Lime	25
"	9.	Labor	7 50
"	11.	Expressage	46
"	25.	Expressage	60
"	28.	Gum labels	3 25
"	28.	Freight and cartage	1 54
June	3.	Glucose	20
"	4.	Telegrams	1 05
"	6.	Milk record blanks	4 00
"	6.	Expressage	25
"	6.	Buckwheat	7 56
"	24.	Expressage	2 36
"	24.	Ruby lamp	50
"	25.	Spray nozzles	3 50
"	29.	Picture and frame	2 90
"	29.	Labor	64 66
		Total for Agricultural Division	$539 72

FOR HORTICULTURAL DIVISION.

1900.			
July	2.	Labor	$32 50
"	10.	Labor	22 50
"	18.	Hay	40 68
Aug.	2.	Labor	41 75
"	5.	Telegrams	77
		Amount carried forward	$138 20

1900.		Amount brought forward	$138 20
Aug.	9.	Drugs	2 40
"	10.	Freight and cartage	1 08
Sept.	1.	Labor	70 00
"	4.	Horseshoeing	7 05
"	4.	Bran	2 15
"	4.	Crates and baskets	4 85
"	4.	Labor	20 88
"	10.	Labor	13 20
"	24.	Labor	17 10
"	29.	Labor	37 50
Nov.	1.	Labor	37 50
"	26.	Paint	1 95
"	26.	Horseshoeing	1 90
"	30.	Fruit baskets	10 93
Dec.	1.	Labor	37 50
"	1.	Labor	6 06
"	3.	Fruit trees	9 77
"	31.	Labor	37 50
1901.			
Jan.	3.	Horseshoeing	1 50
"	3.	Record books	90
"	10.	Pencils	65
"	31.	Labor	37 50
Feb.	11.	Harness repairs	1 60
"	11.	Wagon repairs	8 25
"	11.	Horseshoeing	1 50
Mar.	1.	Labor	37 50
"	2.	Publications	9 68
"	19.	Drugs	1 60
"	30.	Labor	37 50
Apr.	5.	Photo supplies	4 40
"	8.	Flower seeds	77
"	8.	Grass seed	2 00
"	8.	Sundry hardware supplies	33 08
"	8.	Plants	1 50
"	8.	Flower seeds	1 05
"	12.	Photo supplies	65
"	12.	Office supplies	30 40
"	30.	Labor	43 95
June	1.	Labor	37 50
"	6.	Nursery stock	8 95
		Amount carried forward	$759 95

1901.	Amount brought forward	$759 95
June 3.	Lawn mower	10 35
" 6.	Envelopes and printing	17 30
" 5.	Expressage	85
" 6.	Lantern slides and photo supplies	22 72
" 6.	Publications	3 00
" 6.	Fertilizers	4 25
" 6.	Library Index Cards	2 00
" 6.	Drugs	50
" 6.	Nursery stock	10 50
" 6.	Insecticides	2 50
" 6.	Grass seed	2 25
" 6.	Drugs	8 90
" 6.	Photo supplies	7 36
" 6.	Cabinet work	12 75
" 6.	Publications	6 00
" 6.	Lantern slides	6 85
" 6.	Dry plates	3 01
" 6.	Labor	2 80
" 18.	Lantern slides	4 50
" 18.	Hardware supplies	22 41
" 20.	C. E. Hunn, traveling expenses	18 35
" 22	Expressage	1 53
" 26.	Dry plates	13 88
" 26.	Nursery stock	42 00
" 29.	Expressage	35
" 29.	Photo supplies	1 60
	Total for Horticultural Division	$988 46

FOR CHEMICAL DIVISION.

1900.		
July 10.	Gas and sundry supplies	$75 28
Oct. 27.	Labor	2 88
1901.		
June 20.	Gas and chemical supplies	55 00
" 24.	Gas	2 57
" 25.	Rubber stamps	1 00
" 25.	Sundry supplies	80
" 28.	Roll top desk	19 00
" 29.	Electric stove	5 88
" 29.	Glass jars, etc	14 68
" 29.	Expressage	40
	Total for Chemical Division	$177 49

FOR BOTANICAL DIVISION.

1900.		
July 5.	Expressage	$1 10
" 13.	Expressage	7 51
Sept. 15.	Expressage	90
" 29.	Expressage	1 35
Oct. 5.	Dry plates	25 93
" 31.	Glass tubes	1 75
Nov. 15.	Publications	10 48
" 20.	Expressage	35
Dec. 22.	Slides and photo work	23 31
1901.		
Jan. 10.	Publications	1 44
Mar. 2.	Publications	2 55
" 9.	Publications	48
Apr. 23.	Expressage	65
May 17.	Expressage	1 56
June 14.	Dry plates and slides	26 99
" 25.	Microscope	60 75
" 25.	Chemicals	16 50
" 27.	G. F. Atkinson, traveling expenses	6 86
" 29.	Sterilizer, drying oven, balance and supplies	89 22
" 29.	Paper and envelopes	16 48
" 29.	Expressage	50
	Total for Botanical Division	$296 66

FOR ENTOMOLOGICAL DIVISION.

1900.		
July 27.	Labor	$6 00
Aug. 1.	Labor	18 10
" 11.	Dry plates	14 55
" 15.	Bristol board	1 55
" 24.	Photo supplies	19 27
" 25.	Expressage	1 50
" 31.	Sundry supplies	2 35
Sept. 1.	Labor	19 80
" 1.	M. V. Slingerland, traveling expenses	13 37
" 4.	Photo supplies	1 30
" 4.	Copy book	2 00
" 7.	Expressage	2 10
" 10.	Office supplies	5 60
" 10.	Set water colors	2 10
	Amount carried forward	$109 59

1900.	Amount brought forward	$109 59
Sept. 15.	Expressage	40
" 20.	M. V. Slingerland, traveling expenses	12 45
" 20.	Dry plates, etc.	12 24
" 29.	Expressage	2 15
Oct. 23.	Screens.	2 37
Nov. 26.	Wire cloth	1 10
1901.		
Jan. 3.	Book binding	9 15
May 24.	Half tone	5 00
" 25.	Expressage	30
June 22.	Expressage	30
" 24.	Microscope and supplies	83 89
" 28.	Case of drawers	60 00
	Total for Entomological Division	$298 94

SUMMARY.

The Agricultural Experiment Station of Cornell University,
In account with
The United States Appropriation.

1901. *Dr.*

To Receipts from Treasurer of the United States as per appropriation for the year ending June 30, 1901, under Act of Congress approved March 2, 1887		$13,500 00

Cr.

June 30. By Salaries	$8,936 77	
Office and Printing	2,261 96	
Agriculture	539 72	
Horticulture	988 46	
Chemistry	177 49	
Botany	296 66	
Entomology	298 94	
		$13,500 00

RECEIPTS.

Balance from 1899-1900	$287 03	
Receipts from sale of produce	110 84	
		$397 87

DISBURSEMENTS.

Repairs on Insectary	$24 48	
Fertilizers	48 75	
Dictionary	15 00	
Traveling expenses	15 81	
Labor	47 67	
Sundry supplies	7 31	
Balance on hand June 30, 1901	238 35	
		$397 87

APPENDIX III.

Nature-Study Quarterlies.

No. 6. How Plants Live Together.
No. 7. A Hill of Potatoes.
No. 8. A Study of Fishes.
No. 9. A Chat with the Reader.

READING-COURSE FOR FARMERS.

No. 10. Soiling Crops and Silage.
No. 11. A Tree.
No. 12. Orcharding, A Survey of the Preliminaries.
No. 13. Orcharding, Management of the Orchard.
No. 14. Orcharding, Care of the Tree.
No. 15. Orcharding, Handling of the Fruit.

JUNIOR-NATURALIST MONTHLIES.

No. 9.	Oct.,	1900.	Autumn Leaves.
No. 10.	Nov.,	1900.	A November Walk.
No. 11.	Dec.,	1900.	The War Among the Trees.
No. 12.	Jan.,	1901.	The Snow Storm.
No. 1.	Feb.,	1901.	Winter Pruning.
No. 2.	Mar.,	1901.	Robin.
No. 3.	April,	1901.	Something for Young Farmers.
No. 4.	May,	1901.	Nature in Summer.

READING-COURSE FOR FARMERS' WIVES.

No. 1. Saving Steps.
No. 2. Home Sanitation.

Circular of Information.

October, 1900.

CORNELL
NATURE-STUDY QUARTERLY

No. 6.

Issued by the College of Agriculture and Experiment Station of Cornell University, under Chapter 430 of the Laws of 1899, of the State of New York.

I. P. ROBERTS,
Director.

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1900.

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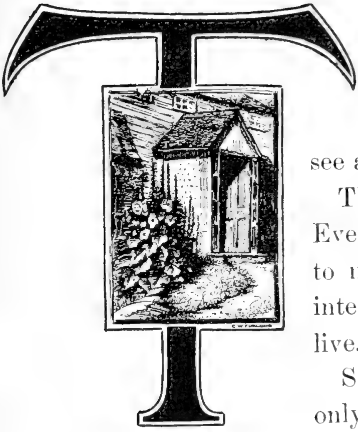
HOW PLANTS LIVE TOGETHER.

L. H. BAILEY.



TO the general observer, plants seem to be distributed in a promiscuous and haphazard way, without law or order. This is because he does not see and consider.

The world is now full of plants. Every plant puts forth its supreme effort to multiply its kind. The result is an intense struggle for an opportunity to live.

Seeds are scattered in profusion, but only the few can grow. The many do not find the proper conditions. They fall on stony ground. In Fig. 94 this loss is shown. The trunk of an elm tree stands in the background. The covering of the ground, except about the very base of the tree, is a mat of elm seedlings. There are thousands of them in the space shown in the picture, so many that they make a sod-like covering which shows little detail in the photograph. Not one of these thousands will ever make a tree.

94.—*A carpet of young elms, all of which must perish.*

Since there is intense competition for every foot of the earth's surface that is capable of raising plants, it follows that every spot will have many kinds of plant inhabitants. Plants must live together. They associate. They become adapted or accustomed to

95.—*A plant society waiting for the spring.*

each other. Some can live in shade; they thrive in the forest, where sun-loving plants perish. Others prefer the sun, and thereby live together. There are plant societies.

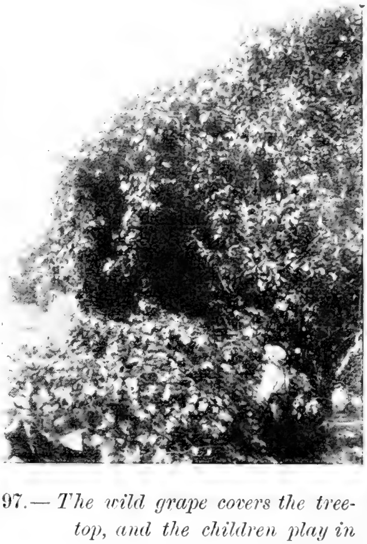
Every distinct or separate area has its own plant society. There is one association for the hard tramped door-yard,—knot-weed and broad-leaved plantain with interspersed grass and dandelions; one for the fence-row,—briars and choke-cherries and hiding weeds; one for the dry open field,—wire-grass and mullein and scattered docks; one for the slattern roadside,—sweet clover and ragweed and burdock; one for the meadow swale,—smartweed and pitchforks; one for the barn-

96.—*Weak, narrow-leaved grasses grow in the cat-tail forest.*

yard,— rank pigweeds and sprawling barn-grass; one for the dripping rock-cliff,— delicate bluebells and hanging ferns and grasses. Indefinitely might these categories be extended. We all known the plant societies, but we have not thought of them.

In every plant society there is one dominant note. It is the individuality of one kind of plant which grows most abundantly or overtops the others. Certain plant forms come to mind when one thinks of willows, others when he thinks of an apple orchard, still others when he thinks of a beech forest. The farmer may associate "pussly" with cabbages and beets, but not with wheat and oats. He associates cockle with wheat, but not with oats or corn. We all associate dandelions with grassy areas, but not with burdocks or forests.

It is impossible to open one's eyes out-of-doors, outside the paved streets of cities, without seeing a plant society. A lawn is a plant society. It may contain only grass, or it may contain weeds hidden away in the sward. What weeds remain in the lawn? Only those which can withstand the mowing. What are they? Let a bit of lawn grow as it will for a month, and see what there is in it. A swale, a dry hillside, a forest of beech, a forest of oak, a forest of hemlock or pine, a weedy yard, a tangled fence-row, a brook side, a deep, quiet swamp, a lake shore, a railroad, a river bank, a meadow, a pasture, a dusty roadway,— each has its characteristic plants. Even in the winter one may see these societies, the tall plants still asserting themselves, others of less aspiring stature, and others snuggling just under the snow (Fig. 95).



97.— *The wild grape covers the tree-top, and the children play in the bower. The grape is searching for light.*

Often these societies are in the nature of overgrowth and undergrowth — one society living beneath another. Of such are forest societies. Few woods are so dark that some plants do not grow on the ground, unless they are evergreen or coniferous woods. Even

in humbler communities the overgrowth and undergrowth are usually apparent if one looks closely. Separate the cat-tails in the dense swamp and see the weak and narrow-leaved grasses growing between (Fig. 96). Note the clover, young grasses and other plants between the grass in the meadow; the farmer says that his meadow has good "bottom."

Some plants even grow on top of other plants. It is their way of getting light. Of such are the climbers. Note the mantle which the wild grape throws over the trees (Fig. 97). Often the supporting tree is smothered and killed.

98.— *A colony of clotbur.*

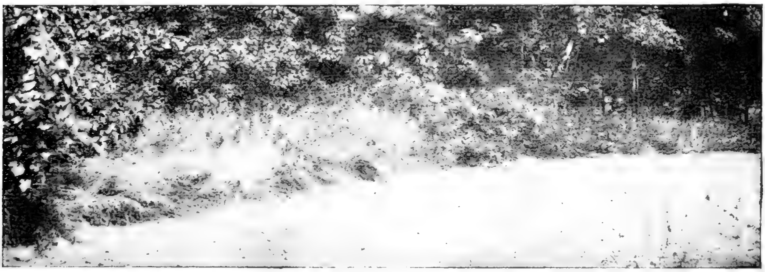
When an area is newly cleared many plants rush for it. Quickly it is covered with ambitious growths — poke weeds, fireweeds, thistles, briars, nettles. Often each plant occupies large places alone, making clumps or patches. These patches are plant colonies, made up mostly of one species or kind (Fig. 98). But as the struggle tightens other plants insinuate themselves into the colony and it is broken up; a mixed population results. Sometimes these colonies are broken up by the shade of trees and tall bushes which have come up near them, for all neglected areas in this part of the world tend to return to forest if they are not mowed, pastured or burned. Mowed and pastured areas run into grass, for the grass withstands the cutting and grazing. In burned areas the struggle begins anew when the fire has passed.

Plant societies are easy of study by the school. Their study appeals to the desire of exploration and adventure, and it adds zest to the excursion. Go to a swale, swamp, roadside, forest, weedy field or other place, and ask the pupil to note: (1) that the flora of the place is unlike that of places with different physical features; (2) that these particular plants grow together because they all

can survive under similar conditions; (3) what these conditions are,—whether, sun, shade, dry soil, wet soil, sand, clay, rock; (4) what particular plant is most abundant or gives character to the society.

99.— *Two plant societies,— the close-bitten sward and the rushy pond.*

Study one society thoroughly. Make lists of the kinds of plants and of the relative numbers of each. If the names of the plants



100.— *The edge of the road. Trees and bushes crowd the drive-way, and a ribbon of grass and weeds has pushed itself to the very margin.*

are not known, call them by numbers; make dried specimens of them for reference. When another society is visited, repeat these observations, and compare one society with another.

Ask every plant why it grows there.

NOTES.

It is not yet too late for the planting of spring bulbs, as crocus, hyacinth, narcissus and others. Our Quarterly No. 2 contains directions for the work. A reprint of these directions can be had by making application for it.

*   *   *

The autumn colors and the mode of falling of leaves are suggestive topics for nature-study in the late fall.

*   *   *

The autumn is a season of activity with birds. They are flocking and preparing for their southern journey. Bright plumage is not so often seen as in the spring. A large proportion of the individuals are young and they lack the rich colors of the adults, or they have the sober dress of the female. Some of the old birds, as the male bobolink and scarlet tanager, have donned more inconspicuous garbs and are less visible to their enemies while on their southern journeys. The autumn has many kinds of birds. Besides our permanent residents like the chickadee, nuthatch, bob-white and other species which remain at all times, there still linger after the nesting time many migrating summer birds to feed on fruits, seeds and grain. Among the migrants are most of our warblers, such small thrushes as the olive-back and hermit, and many sparrows including the sweet-voiced white throat. The great majority of our aquatic birds, and a few birds of prey, are migrants.

January, 1901.

CORNELL
NATURE-STUDY QUARTERLY

NO. 7.

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I. P. ROBERTS,
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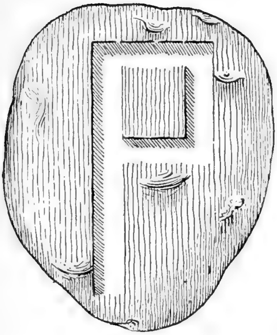
A HILL OF POTATOES.

I. P. ROBERTS.



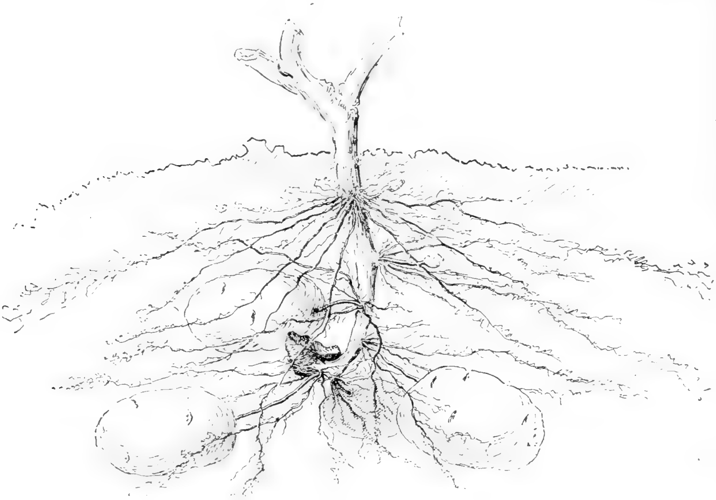
PLANT a hill of potatoes. You can do it in the school room. Plant in a box or a flower-pot. Keep the box warm, and do not let the soil dry out. Plant whole tubers and pieces of tubers. Plant pieces of various sizes. Plant some that have no "eyes." Plant shallow — so that the tuber is just covered with soil — and deep. Watch the results.

All plants are abundantly supplied with means for reproducing their kind: some by seed, some by multiplication at the crown or base or by roots, others by means of underground stems; and some, as the potato, have two or more means of reproduction. In its wild or partially improved state the potato is abundantly supplied with fruit, "seed balls," borne on the top of the stalks. The seeds of a single ball often will produce many varieties of potatoes and they cannot be depended upon to reproduce the parent stock. Farmers seldom attempt to raise potatoes from the seeds; when they do it is for the purpose of securing new varieties. The common method of reproduction is to plant a part or all of an enlarged underground stem, that is, a part of the "potato" or tuber.

When the soil is reasonably porous and fertile, a strong root may start at the seed piece and descend more or less directly into the subsoil. In most cases, however, the roots spread laterally. This is a good illustration of how plants may vary in their root habits in order to adapt themselves to their environment. Notice where the roots form on the plants you are growing. Few farmers know where they form. Distinguish the true or feeding roots from the underground stems. Determine how many tubers

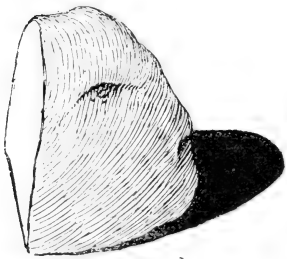
form on each underground stem. Dig up a hill of potatoes from the garden before school closes.

A single eye, with a portion of the tuber attached to furnish nourishment to the bud until sustenance can be secured from



101.— *Underground part of potato plant in mellow soil.*

newly formed rootlets, may produce one, occasionally more, strong upright stems. A most interesting study of manifold reproduction may be made even in the winter time by planting in a fertile soil a piece of potato containing a single eye. As soon as the rootlets begin to start, divide each eye and piece into two parts and replant. In a few days after the rootlets have again started, divide the two pieces into four and replant. This operation may be performed again and again, until many plants suitable for transplanting in the open may be secured from a single eye.

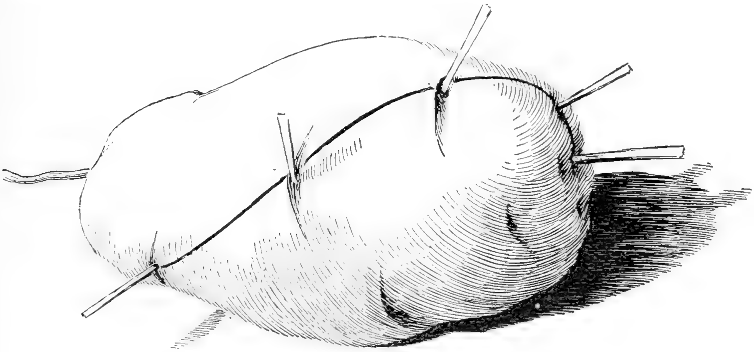


102.—*Piece of tuber for planting, bearing a single eye.*

Demonstrate that the potato contains starch. This can be done by applying a drop of dilute iodine to a freshly cut surface of the tuber: the starch grains turn blue-black. Five cents worth of iodine

purchased at the drug store will be sufficient for many tests. Dilute it about one-half with water. This starch, after being changed to sugar, supplies the young plant with nourishment. Dig up the pieces you have planted and see which start first, shoots or roots.

The "potato" is an enlarged underground stem provided with numerous buds similar to those on the stems of plants above ground. These buds are placed spirally on the underground stem or tuber with a considerable degree of uniformity. As on the stems of other



165.—*How to illustrate the spiral arrangement of the eyes.*

plants, the buds are less numerous and weaker at the base and most numerous and vigorous at the top or upper end. On a smooth well developed long potato, the spiral arrangement of the buds may be illustrated by sticking a tooth-pick or pin in each eye, beginning at the base or stem end, and connecting the pins with a string.

Farm Notes on the Potato.

Having seen the potato growing in the school room, some information may be given respecting its treatment in the field as a crop.

Potatoes are easily raised, even under adverse conditions, although they respond quickly to superior fertility and tillage. The average yield in the United States during the last ten years was 76.6 bushels per acre, although from three to four hundred bushels per acre are not uncommon under superior tillage when soil and climate are at their best.

The area devoted to potatoes during the last decade was two and a half million acres annually. Potatoes do best on a moderately moist and deep soil and in a climate relatively cool.

Since the period of growth is short, varying from three to five months, they should be planted in soil which has an abundance of readily available plant food. Notice in Fig. 101 that most of the underground stems which have produced potatoes leave the main stem about four inches below the surface and but a short distance above the seed-piece. This suggests that the seed should be planted about four inches deep. To produce three hundred bushels of potatoes requires the exhalation of over three hundred tons of water; therefore water or moisture is of quite as much importance in securing large yields as plant food.

It is best to prepare the land deeply, to plant deep, and then to practice nearly or quite level culture. The practice of hilling up potatoes, so common in most parts of the country, is to be discouraged, because it is wasteful of moisture and the tubers do not grow in the coolest part of the soil. For very early potatoes, hilling-up may be allowable. Till the soil very often to save the moisture. For the philosophy of this see Leaflet No. 15.

Not infrequently the potato is seriously injured by blights which attack the leaves. The early blight, which usually appears in June, may destroy some of the foliage, thereby checking growth. The late blight, which also attacks the foliage, is far more serious. It differs little in outward appearance from the early blight. In rare cases the vines are so seriously injured that no potatoes are formed. The potato rot or blight did great damage to the potato in many localities in the United States in 1845. In 1846 the blight appeared in Ireland and virtually destroyed the entire crop. Previous to this date the potato had become the chief food supply of the peasantry. The cultivation of the oat as a food crop had been universal previous to the introduction of the potato, but oats furnished so little food on a given area as compared to the potato that its cultivation at the time the blight appeared had been very largely abandoned. The loss of the potato crop produced widespread famine. The most conservative estimate of the numbers who perished for want of food

or by disease caused by a meager diet of unhealthy and innutritious food is set down at six hundred thousand during the two years of the potato blight. This disease was not so destructive in 1847 as in 1846 and by 1848 it had virtually disappeared. Some one has said that if Great Britain had expended one dollar for investigating the diseases of potatoes where she has spent a thousand dollars for perfecting the engines of war, the terrible famine might have been averted. We now think it a relatively easy matter to keep the blight in check by thorough spraying with Bordeaux mixture.

How the Potato Has Been Improved.

All plants have their origin in pre-existing plants. While the young plant is always similar to the one from which it was derived, it is never exactly like it in every detail. This arises from the fact that all of the conditions under which the parent plant and its offspring grow are never exactly alike. The variations or differences in the plants are usually exceedingly small in a single generation, but occasionally they are wide, in which case they are called "sports" and are usually difficult to perpetuate. If successive generations of plants are reared under continuously improved conditions, there will be a continuous and accumulating variation from generation to generation, which in time may come to be so great as to make it difficult to discover a marked similarity between the wild and cultivated forms of the same plant.

When conditions are undisturbed by man there is found to be a fierce struggle for existence, the hardiest or those best suited to the conditions preponderate, and this without any reference to the wants of mankind. The farmer steps in and selects those plants which give promise of being most useful or most beautiful and then decreases or eliminates the struggle for these selected plants, by destroying the plants which are least desirable, by fertilizing and tilling the soil, by conserving moisture and by improving the physical conditions of the land, thereby making it more comfortable for the plants which he has chosen. The selected or "improved" plant, by reason of being more comfortable and better nourished, tends to vary in one or more directions from the wild and unimproved types.

Whenever these variations tend towards greater productiveness, better quality or enhanced beauty, selection is again made of such specimens as give promise of supplying the wants and gratifying the desires of civilized man. The bettered conditions of the plant, by reason of man's effort, do not usually result in producing like variation along all lines. One part of the plant as the flower, the fruit or the stem, varies more than the other parts. All this tends to break up a single type or stock into many varieties. There are hundreds of varieties of potatoes all traceable to a single wild species. The kind and quantity of nourishment supplied plays the most important part of any single factor in producing variation.

The general character of the cultivated potato plant as to leaf, stem, root and habit of growth, is virtually the same as the wild plant, variation having been directed and accentuated along the line of increasing the size and quality of the underground tubers. This habit of producing enormously enlarged stems has been operating so long that the plant has inherited the power of transmitting this acquired quality to the succeeding plants. The most improved varieties seldom produce seed balls because growth has been directed so largely toward enlarging and multiplying the tubers. By selecting tubers with buds not fully developed and avoiding those with deep, sunken eyes, varieties have been produced with few eyes or buds and these set not in deep indentations but nearly even with the surface of the potato.

NOTES FOR THE TEACHER.

We trust it will be your pleasure to plant some potato tubers in your schoolroom and also to make the iodine test for starch as has been suggested on pages 188, 189. Or, better still, have your pupils plant them under your supervision. Such experiments will give them a forceful illustration of two principles that pertain to all life: Provision for the future (or for welfare of offspring), and excellent methods for attaining such plans. The motive of the potato, if we may so speak, is to make the most of its opportunity for attaining the greatest perfection and also for perpetuating its kind. The manufacture of starch, and storing a quantity for future use, are important factors towards these ends.

That a plant should prepare for its own welfare and also make provision for the offspring seem to place it almost on the plane of having intelligence. That the industrious honey bee shows such foresight is commonly known and the example has long been held up for man's imitation. Why should not the potato be held in similar admiration? If plants were not provident for their future, the world would have an empty cupboard and the full dinner pail would be a meaningless expression.

We wish to say a word about the philosophy of cooking the potato. At first sight the dust-like specks of starch may seem too insignificant for much consideration, but you can impress on your pupils that the grains they see are on the surface only, and that great numbers of other starch grains lie next underneath, and that the aggregate in a good sized potato is very great. If they ask why a raw potato is not as good food as a raw apple, you can explain that each of the starch grains in the potato is covered with a film which offers a strong resistance to the digestive organs of man, but not necessarily of cattle or horses. By heat the starch grains are popped open as heat pops open a kernel of corn. They will easily understand how a kernel of popped corn is more digestible than a raw

kernel. You can judge best whether to tell your pupils that the part of food known as carbohydrates maintains the animal heat of the body. Starch is one of the carbohydrates. There is another element of food in the potato not shown by the iodine test. It is called protein, which makes blood and muscle. One reason why potatoes cook better when placed in hot water instead of in cold water, is that the sudden heat coagulates the protein of the surface and retards the entrance of water through the mass of the potato and thus tends to make them cook less "soggy." Some potatoes, however, cook "soggy" even with the greatest care on the part of the cook. This coagulation also prevents the extraction of the protein from the interior of the potato. This same principle is illustrated in the best method for cooking beefsteak. When the surface is quickly seared by heat there is a coagulation of the protein at that point of the steak that prevents, as we say, "the escape of the juices."

JNO. W. SPENCER.

* * *

Planting a plant will be the subject of our solicitude this spring. We want every Junior Naturalist to plant something, if it is nothing more than a potato. How many children under 14 years ever planted a plant of their own and cared for it during a season? Soon we shall issue a leaflet on the subject. In the meantime be thinking about interesting the children in planting something.

* * *

The Teachers Home Nature-Study Course is to be improved and enlarged. Heretofore we have not been able to give it the attention that it deserves. Now we are ready to push it. We want you to co-operate with us. We shall publish a monthly lesson. Any teacher in New York State may enroll. Our Farmers' Reading Course has over 20,000 readers. We wish that our Teachers' Course were as large.

* * *

The days are lengthening. Before we are aware, there will come a soft and velvet spot in the winter days, known as the February thaw. The streams will be bank-full of roistering, swirling water. The ice will be tilted along the brook margins, and the sleighing

will be patchy. Then we shall wait for the first vision of the robin and for the "disembodied voice" of the bluebird. Then will come the epidemic of "spring fever." The disease is "catching."

Try to direct the spring energies of the pupil into resourceful lines of work. Be prepared for the "burst of spring." Look up questions of birds, bird houses, aquariums and breeding-cages. Always connect the schoolroom observations with the things as they exist in the fields. Whenever possible, begin the observations in the field rather than in the house. We shall be glad to give suggestions.

* * *

With the return of the spring enthusiasm is the time to push the organization of Junior Naturalist Clubs. Have you organized clubs in your grades? You will find that the clubs will aid you in maintaining interest and discipline in the regular school work. We will attend to all the detail of the correspondence, and thereby relieve you of any feeling of responsibility. If you contemplate organizing a club, write us for particulars and instructions. In the State of New Yerk there is no expense to either teachers or pupils.

* * *

We desire to keep in the closest possible touch with our many thousand teachers. If you have attempted any nature-study work, we should like to know what your successes and failures have been. Tell us what subjects you find to be the best for your conditions. Mention the ages of the children.

* * *

We hope that at some time you have studied twigs. See our leaflet on "Four Apple Twigs." The winter twig records an astonishing range of history. If your pupils have studied twigs in the schoolroom, it is then a good plan to assign each one a twig on a tree or bush. Allow the twig to remain on its plant, label it, and then let the children watch it as the buds swell and the leaves come out. On the first warm day, let them make a drawing and description of the twig while it is still in its winter dress.

L. H. BAILEY, *Chief of Bureau of Nature-Study.*
JOHN W. SPENCER, *Deputy Chief.*

January, 1901.

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A STUDY OF FISHES.

H. D. REED.

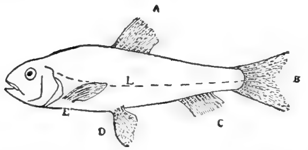
THE first forms of animal life which attract the young naturalist's attention are doubtless the birds. These are most interesting to him because of their beautiful colors, their sweet songs and the grace with which they fly through the air. But who has watched the fishes in a brook or an aquarium and is not able to grant them a place, in beauty, grace, and delicate coloration, equal to the birds? To be sure fishes cannot sing, but there are so many other interesting facts in connection with their habits and life-histories that it fully makes up for their lack of voice.

The Parts of a Fish.

While observing a living fish and admiring its beauty, it will probably occur to some of us that a fish consists only of a head and tail. But this is not all. Between the head and tail is a part that we may call the trunk. It contains the digestive and other organs. There is no indication of a neck in a fish. Any such constriction would destroy the regular outline of the animal's body and thus retard the speed with which it moves through the water. But head, trunk and tail are not all. There are attached to the outer side of the fish's body certain appendages that are called fins.

Before discussing some of the different kinds of fishes and their habits, it will be necessary to learn something about fins, for the fins of all fishes are not alike. When a fish moves through the water, it bends its tail first to one side and then to the other. This undulatory movement, as it is called, pushes the fish's body ahead. One can observe the movements easily upon a specimen kept alive

in an aquarium jar. At the extreme end of the tail there is a broad, notched fin which aids the tail in propelling and steering the body. We will call this the *tail* or *caudal* fin (Fig. 104, B). In most of our common fishes there are seven fins,— six without the caudal. The first of these six is a large fin situated near the middle of the back. This is the *back* or *dorsal* fin (Fig. 104, A) Sometimes we may find a fish that has two dorsal fins. In this case the one nearest the head is called first dorsal and the next one behind it the second dorsal. Near the head, in a position corresponding to our arms, is a pair of fins which are called the *arm* or *pectoral* fins (Fig. 104 E). Still farther towards the tail, on the under side of the fish, is another pair, corresponding in position to the hind legs of a quadruped. This pair is called the *leg* or *pelvic* fins (Fig. 104, D). Just behind the pelvic fins is a single fin, situated on the middle line of the body. This is the *anal* fin (Fig. 104, C). The pectoral and pelvic fins are called paired fins because they are in pairs. The others which are not in pairs are called median fins, because they are situated on the middle line of the body. The paired fins serve as delicate balancers to keep the body right side up and to regulate speed. They are also used to propel the body backwards. After naming the different fins of the fish in the schoolroom aquarium, it will be interesting to observe the uses of each.

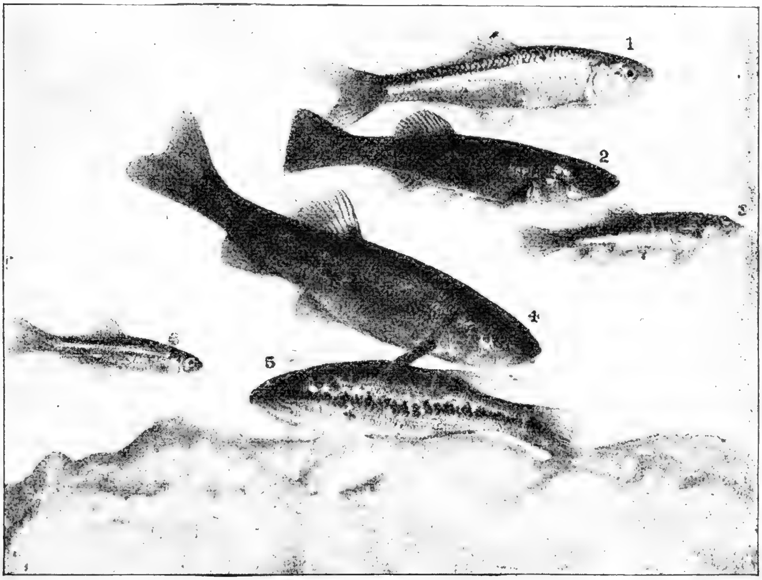


104.— *Diagram of a fish to show: A, dorsal fin; B, caudal fin; C, anal fin; D, pelvic fins; E, pectoral fins; L, lateral line.*

On the side of the body, extending from the head to the caudal fin, is, in most fishes, a line made up of a series of small tubes which open upon the surface. This is called the *lateral line*, and acts in the capacity of a sense organ (Fig. 104, L). Is the lateral line straight or curved? Does it curve upwards or downwards? Does the curvature differ in different kinds of fishes? Do all the fishes you find possess a lateral line? Is the lateral line complete in all fishes,— *i. e.*, does it extend from the head to the caudal fin without a single break?

Where Fishes Spend the Winter.

As winter approaches and the leaves fall and the ground becomes frozen, the birds leave us and go farther south into warmer climates where food is more abundant. We are all familiar with this habit of the birds, but how many of us know or have even wondered what the fishes have been doing through the cold winter months while the streams and ponds have been covered with ice? Before the warmth of spring comes to raise the temperature of the streams,



105.—*1, Shiner; 2, Barred Killifish; 3, Black-nosed Dace; 4, Creek Chub; 5, Young of Large-mouthed Black Bass; 6, Varying-toothed Minnow.*

let us go to some familiar place in a brook where, during the summer, are to be found scores of minnows. None are to be found now. The brook shows no signs of ever having contained any living creatures. Suppose we go farther up or down the stream until we find a protected pool the bottom of which is covered with sediment and water-soaked leaves. With our net we will dip up some

of the leaves and sediment, being sure that we dip from the very bottom. On looking over this mass of muddy material we may find a fish two or three inches long, with very fine scales, a black back, a silvery belly and a blackish or brown band on the side of the body extending from the tip of the nose to the tail. This is the *Black-nosed Dace* (Fig. 105). If specimens of this fish are caught very early in the spring, one will be able to watch some interesting color changes. As the spawning time approaches the dark band on the sides and the fins change to a bright crimson. Sometimes the whole body may be of this gaudy color. During the summer the lateral band becomes orange. As the season goes, the bright colors gradually fade until finally, in the fall and winter, the little black-nose is again clothed in his more modest attire. A great many of the fishes, and especially the larger ones, seek some deep pond or pool in the stream at the approach of winter and remain near the bottom. If the pond or stream is so deep that they do not become chilled, they will remain active, swimming about and taking food all winter. But when the stream is very shallow and the fishes feel the cold, they settle down to the bottom, moving about very little and taking little or no food. The carp collect in small numbers and pass the winter in excavations that they make in the muddy bottom. If the débris thrown up by the water across the marshy end of a lake be raked over during the winter, one will probably find some of the smaller catfishes spending the season in a semi-dormant state.

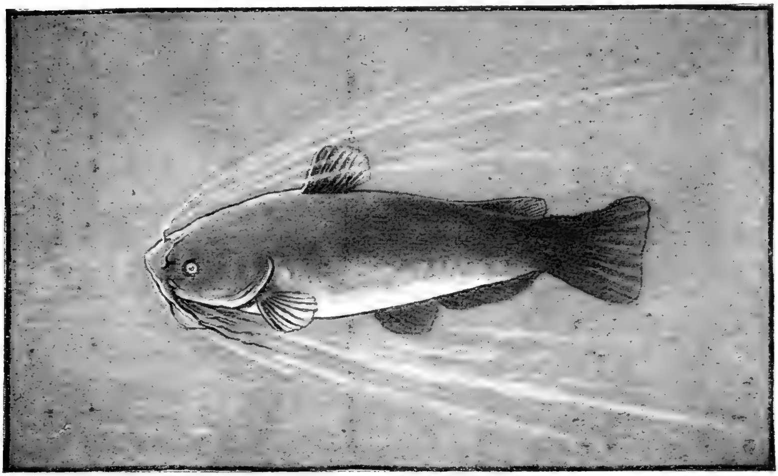
Some interesting experiments may be tried with the fishes in the aquarium jar. Keep them for a few days where it is cold and then bring them into a warmer room and note the difference in their activity.

The Common Catfish or Bullhead.

This sleepy old fellow differs in many respects from most of our common fishes. He has no scales. About the mouth are eight long whisker-like appendages, called barbels (Fig. 106). Perhaps he is called catfish because he has whiskers about his mouth like a cat. Anyone who has ever taken a catfish from the hook probably knows

that care is needed in order not to receive a painful prick from the sharp spines in his pectoral and dorsal fins.

There is nothing aristocratic about the catfish. In warm pools and streams where the water is sluggish and the muddy bottom is covered with weeds, he may be found moving lazily about in search of food. His taste is not delicate. Animal substance, whether living or dead satisfies him. When in search of food he makes good



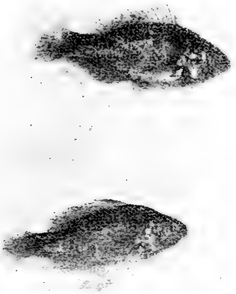
106.—*The common Catfish or Bullhead.*

use of his barbels, especially those at the corners of his mouth, which he uses as feelers. The catfish will live longer out of water than most of our other food fishes. They will live and thrive in water which is far too impure for "pumpkin seeds" or bass. They spawn late in the spring. The mother fish cares for her young much as a hen cares for her chickens. When they are old enough to take care of themselves she weans them.

The Common Sun-fish or Pumpkin Seed.

Some evening just at sunset visit a quiet pool in a nearby stream. Drop in your hook baited with an "angle worm" and presently the dancing cork shows that you have a "bite." On "pulling up" you

find that you really have a fish. It is a beautiful creature, too,—thin flat body shaped something like the seed of a pumpkin. His back is an olive green delicately shaded with blue. His sides are spotted with orange, while his belly is a bright yellow. His cheeks are orange-color streaked with wavy lines of blue. Just behind his eye on his "ear-flap" a bright scarlet spot. This is the common *Sun-fish* or *Pumpkin Seed* (Fig. 107). He is a very beautiful, aristocratic little fellow, "looking like a brilliant coin fresh from the mint."



107.—*The common Sun-fish or Pumpkin-seed.*

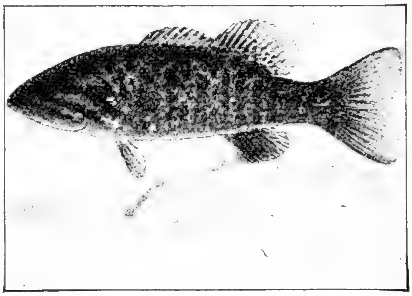
Keep him alive in an aquarium jar with a shiner. Compare the two fishes as to the size and shape of their bodies and fins. Feed them different kinds of food, such as worms, insects and crackers, and try to discover which they like best and how they eat.

The sun-fishes prefer quiet waters. They lay their eggs in the spring of the year. The female selects a spot near the banks of the stream or pond where the water is very shallow and contains an abundance of water plants. Here she clears a circular area about a foot in diameter. After making an excavation of three inches or more in the gravel or sand the nest is completed. The eggs are then deposited in the basin-like excavation. She watches her nest and eggs with great diligence, driving away other fishes that chance to come near.

The Black Basses.

The black basses are not usually found in small streams where it is most pleasant for teachers and pupils to fish. They are fishes which seek the rivers and lakes. There are two kinds of black bass, the *Large-mouthed* and the *Small-mouthed*. As the name indicates, the two may be distinguished by the size of the mouth. In the large-mouthed black bass, the upper jaw extends to a point behind the eye, while in the small-mouthed species it extends to a point just below the middle of the eye (Fig. 108).

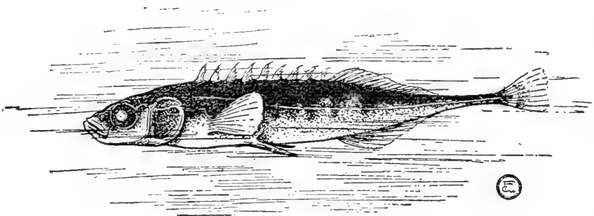
Both kinds of black bass may be found in the same body of water. The character of the bottoms over which they are found, however, differs. The small-mouthed prefers the stony bars or shoals. The large-mouthed, on the contrary, selects a muddy bottom grown over with reeds. They feed upon crayfish ("crabs"), minnows, frogs, worms, tadpoles and insects. Our black basses are very queer parents. They prepare a nest in which the eggs are deposited. Both male and female are very courageous in the defense of their eggs and young. As soon as the young fishes are able to take care of themselves the parent fishes leave them, and after that time may even feed upon their own children.



108.—*Adult Small-mouthed Black Bass.*

The Stickleback.

The sticklebacks are queer little fellows, indeed (Fig. 109). The slender body, extremely narrow tail and the sharp, free spines in front of the dorsal fin, give them at once the appearance of both an active and a pugnacious little creature. The sticklebacks are detrimental to the increase of other fishes, since they greedily destroy the spawn and young of all fishes that come within their reach. They build nests about two inches in diameter, with a hole in the top. After the eggs are laid the male defends the nest with great bravery. The little five-spined brook stickleback in the Cayuga Lake Basin, N. Y., is most commonly found in stagnant pools, shaded by trees, where the water is filled with decaying veg-

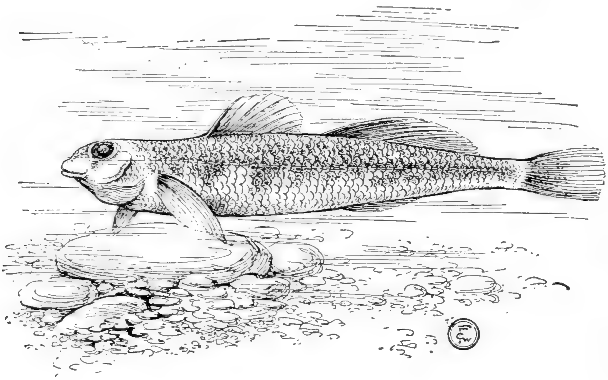


109.—*A Stickleback.*

etable matter,—the so-called "green frog-spawn" (spirogyra) and duckweed. If you supply the sticklebacks with plenty of fine vegetable material, you may induce them to build a nest in the aquarium jar, but they must be caught and placed in the jar early in the season before they spawn.

The Johnny Darters.

In New York State every swift stream which has a bed of gravel and flat stone ought to contain some one of the Johnny darters, for there are a great many different kinds (Fig. 110). They are little creatures, delighting in clear water and swift currents, where they dart about, hiding under stones and leaves, or resting on the bottom with their heads upstream. The body of a darter is compact and spindle-shaped, gradually tapering from the short head to a narrow tail. The eyes are situated nearly on top of the head. The color of the darters varies greatly with the different kinds. Some are very plain, the light ground color being broken only by a few brown markings. Others are gorgeous in their colorings, it seeming as if they had attempted to reproduce the rainbow on their sides. Such kinds are indeed very attractive and are ranked with the most beautifully colored of all our common fishes. When a darter swims he appears bird-like, for he flies through the water much as a bird flies through the air. He does not use his tail alone in swimming as the catfish, the sunfish, the stickleback, and most of the other fishes do, but flies with his pectoral fins.



110.—*A Johnny Darter*

You surely must have a Johnny darter in your aquarium jar. The Johnnies are true American fishes. Though small, they face

the strong currents and eke out a living where their larger cousin, the yellow perch, would perish. There are many interesting facts which may be learned from the Johnny darters when kept alive in an aquarium. When not actually moving in the water, do the Johnnies rest on the bottom of the jar or remain suspended in the middle apparently resting on nothing as the other aquarium fishes do? When a fish remains still in the middle of the jar, he does so because he has a well developed air-bladder to help buoy him up and when a fish dies it is the air-bladder which causes him to turn over and rise to the top. Now if the Johnnies always rest on the bottom of the jar when not swimming and if one happens to die and does not rise to the top we may know that, if he has an air-bladder at all, it is only a rudimentary one. It would be interesting also to find out for ourselves if a Johnny darter can really "climb trees" (I mean by trees, of course, the water plants in the aquarium jar), or if he can perch upon the branches like a bird.

The Minnows.

All the small fishes of the brooks are called minnows, or more often "minnies," by the boy fisherman. The boy believes that they grow into larger fishes. This is not true. The minnows are a distinct group of fishes and, for the most part, small ones. They do not grow to be bass or pike or sunfishes or anything else but minnows. Some of the minnows, however, are comparatively large. Two of these are the *Creek Chub* (Fig. 105), and the *Shiner* (Fig. 105). The chub is the king of the small brooks, being often the largest and most voracious fish found in such streams. His common diet probably consists of insects and worms, but if very hungry he does not object to eating a smaller fish. During the spawning season, which is springtime, the male chub has sharp, horny tubercles or spines developed upon the snout. We are able to recognize the Creek chub by means of a black spot at the front of the base of the dorsal fin.

The shiner or red-fin has much larger scales than the chub. The back is elevated in front of the dorsal fin, giving him the appearance of a hump-back. His sides are a steel-blue with silvery reflec-

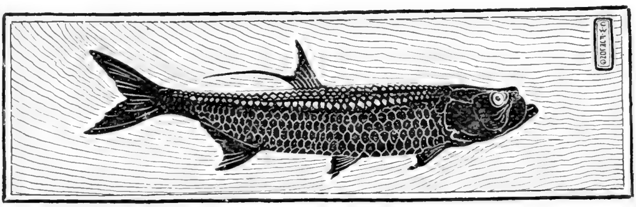
tions. While the shiner is not the largest, it is almost everywhere one of the most abundant brook fishes. In spring the lower fins of the male become reddish. Like the chub, he has small horny tubercles developed on the snout.

Random Notes.

Did you ever see a fish yawn? Watch a shiner in your aquarium. Sometimes you may see him open his mouth widely as though he was very sleepy. Again you may find him resting on the bottom of the jar taking a nap. Fishes cannot close their eyes when they sleep for they have no eyelids.

A convenient way to collect fishes for the schoolroom aquarium is to use a dip net. The ordinary insect net will do but it is better to replace the cheese-cloth bag by a double thickness of mosquito-bar, thus enabling one to move the net through the water more rapidly. By dipping in the deep pools, among grasses and under the banks with such a net, one can soon obtain fishes enough to stock an aquarium (Fig. 111). The aquarium jar should never be placed in the sun. It is better to have only three or four fishes in an aquarium at one time. Some flat stones on the bottom of the jar will afford them convenient hiding places. For further notes on aquaria, consult Leaflet No. 11.

111.—*A convenient form of aquarium jar supplied with water plants. The bottom is covered with clean sand and flat stones.*

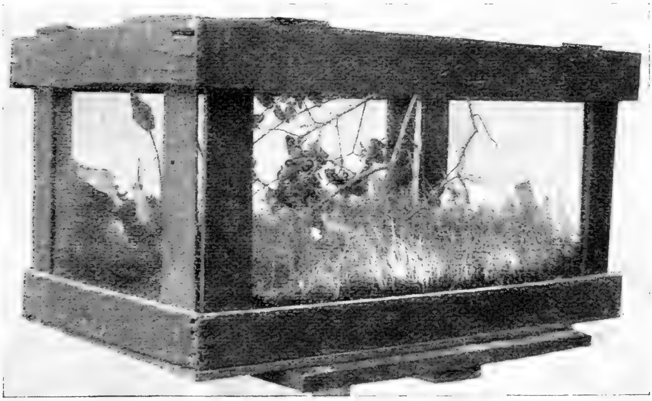


THE STORY OF A TERRARIUM FROM FALL UNTIL SPRING.

ALICE I. KENT.

And Nature, the old nurse, took
  The child upon her knee,
Saying: "Here is a story book
  Thy Father has written for thee."
—*Longfellow to Agassiz.*

Fortunate are the children and the teachers who are so placed that Nature's story book is close at hand. But city children and their teachers need not despair, for the old nurse is loving and bountiful and will rewrite, in living characters, many a page from the wondrous book, for those who care to read. One such a page



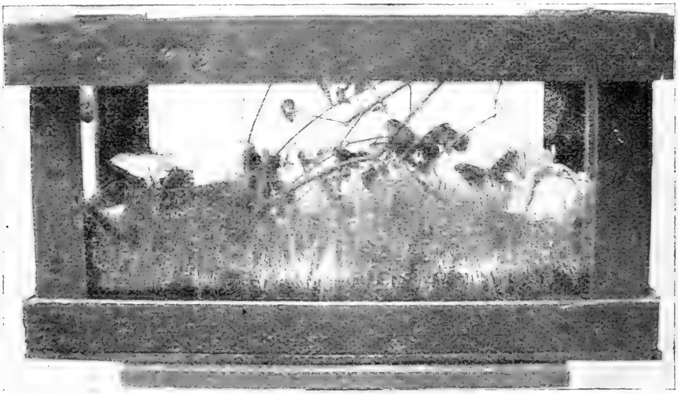
112.—*Life in the terrarium.*

may be a terrarium,—a confined plot of earth on which things may live and grow. (From *terra* "earth," as aquarium is from *aqua*, "water.") Within its narrow confines, the whole drama of the beautiful life of many a tiny creature may be rewritten.

Here is a fragment of the drama, as written in one terrarium.

This terrarium was made from an old berry-crate (Figs. 112, 113).

When the children saw it first, last fall, this is what it looked like: a large rectangular box, grass-green in color, thirty-nine inches long, eighteen inches wide and fifteen inches high. The long sides were of glass, the short sides and top of green wire netting. The top could be removed like the lid of a box. It stood upon a pedestal-table provided with castors. In the bottom of the terrarium were three inches of rich soil, covered with the delicate green of sprouting grass-seed. In one corner was a mossy nook, and in another a mass of thistles and clover. At one end, a small cabbage was planted, and at the other lay several sprays of glossy pin-oak. Suspended from the top, was a large spray of purple thistles.



113.—*Butterfly-time in the terrarium world.*

Among the thistles in the corner, ten pendants of vivid green, bright with golden points, could be seen. They were the chrysalides of the monarch, or milkweed butterfly. Amongst the cabbage leaves were many of the pale green eggs and several of the caterpillars of the cabbage butterfly. Amongst the sprays of oak in the corner, several oak caterpillars were feeding.

Before many days had passed, the drama of life began. One by one, the chrysalides of the milkweed butterfly paled in color and, becoming transparent, showed through their whitened walls the orange colored wings of the developing butterflies within. They then burst, freeing their gorgeous tenants. This happened until there were seven butterflies in the terrarium. As two of these

proved discontented with their new home, they were set free. The five others spent the little round of their aërial life seemingly happy and satisfied. They lived from three to six weeks and showed some individuality in their tastes and habits. Sometimes they chose the mossy corner for their resting place. On other occasions they preferred the netting at the ends and top of the terrarium. In fact, the netting at the ends of the terrarium was a source of pleasure to these butterflies, as it served as a secure resting place and an agreeable and convenient pathway to the top. One of them spent nearly all its life on the thistles suspended from the top. These thistles were kept fresh a long time by placing their stems in a large sponge which was frequently drenched with water.

The butterflies showed some individuality in their eating also. Thistle, clover, golden-rod, nasturtiums and honey-suckle were offered to them. The thistle and the golden-rod were most frequently visited and, next to these, the nasturtiums were most favored. Another fact noted was that most of the butterflies continued to visit the flower first chosen. When, however, a thick syrup of sugar and water was offered, the flowers were much neglected, only one butterfly persisting in flower-visiting. Golden-rod was its choice. If the syrup were fresh-made every morning and placed in a convenient spot, the butterflies never failed to sip it. The generally slept clinging to the wire-netting at the ends or top of the terrarium.

In the meantime, the cabbage began to attract the watchful eyes of the wondering children. As it had industriously sent out many tiny roots, it proved a safe and satisfactory home for its hidden occupants. Shortly, one by one, the caterpillars began to appear at the edges of the uppermost leaves. Then small tours in the vicinage of the cabbage were begun and, finally, as with the butterflies, the end wire nettings proved to be an easy pathway to the top of the terrarium. Here several found good resting places and slowly changed to chrysalides.

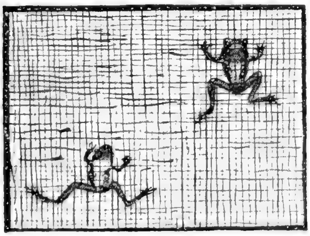
One day a cabbage butterfly obligingly flew in at the open window. It was caught and placed in the terrarium. It, too, proved to be very fond of sugar syrup. One morning, the syrup was acci-

dentally spilled on the wooden ridge at the bottom of the terrarium outside of the netting. The butterfly was so hungry that it could not wait for food more conveniently placed, so it stretched its tongue out, full length, through the netting, and in that way obtained it. The children were surprised to find its tongue somewhat longer than its body.

At this time the cabbage was removed so that the eggs and the remaining young caterpillars could be observed. The protecting coloring of the eggs and caterpillars was first noticed. One little boy at first announced that the caterpillars were green because they were not ripe, a good example surely of the danger of reasoning from analogy!

Very soon the inhabitants of this terrarium world began to increase. A father and two mother grasshoppers and a young one, with his "armor on," came to live there; also a woolly bear, several other species of caterpillars, several species of beetles, a big horse-fly, some lady-bugs and cicada. About this time, too, some very unwelcome immigrants appeared. These were the ichneumon flies. So numerous did they become in a very short time, that they threatened desolation to this prosperous community. Nature's methods were then scrutized and the services of two tree-toads were sought. Their response was immediate and cordial. Soon not a ichneumon fly could be found.

The grasshoppers were partial to celery, over-ripe bananas and moisture. Three days after they became inhabitants of this miniature world, the mother grasshopper dug a hole in the ground and laid eggs. The children then had before them living illustrations of the three stages of grasshopper life.



114.— *Hand over hand.*

The tree-toads were both amusing and accommodating, for they, too, liked the wire-netting at the ends of the terrarium, and delighted the children by climbing up foot over foot, or hand over hand, like odd four-handed sailor boys (Fig. 114). This brought into plain view the tiny suckers on their feet.

After the ichneumon flies had disappeared, a new difficulty arose. The ground became moldy, and the grass died down. The terrarium was then placed by an open window and left there several hours for a number of days until it was thoroughly dried out. Then bird seed was planted and the ground was watered thereafter with a small plant syringe. This gave sufficient, but not excessive moisture, and it was one of the pleasures of the children to imitate a rainy day in the terrarium world. And it was a pleasing experience, for there were splashes of water on the glass sides and many shining drops on the netting and verdure, which soon grew several inches tall; there was the same delightful odor of rich fresh earth that one enjoys during summer rains, and the sunshine touched with brilliancy the gay fall flowers and the gorgeous outspread wings of the butterflies.

At this time the terrarium had an annex in the shape of a wooden box, a foot square, with a gauze top. Here lived two mother spiders with their egg-balls carefully hung on the cobweb beams of their homes. A beautiful yellow silk egg ball was found out of doors one day, and when it was carefully opened to show the eggs with which it was filled, the gratifying discovery was made that these eggs were hatching. They were very tiny and very numerous. They were inclosed in a silken pouch and were the exact color of its lining. When resting the little spiders seemed to hold their legs under the body, and they were so small and so like the egg in general appearance that if they had not run about when disturbed they would never have been discovered. As soon as the egg-ball was opened, they exploited their one talent, for they ran out on the fingers of the person who held the ball and then suspended themselves by almost invisible threads from all parts of the fingers. When they were to be returned to the egg ball, they were gently pushed up. They then obligingly ran back into their silken home, which was carefully closed as before. These little ones were kept a week or ten days and were then allowed to escape and establish homes for themselves. The life history of the spider was thus completed, although unfortunately the adult spiders did not belong to the same species as the young ones.

To return to the terrarium: It was now early in November and

each day found one or more of the terrarium inhabitants missing. One of the caterpillars disappeared and a cocoon made of its own hair was found in its place ; several chrysalides were found on the top of the terrarium ; the butterflies and the grasshoppers, one by one, went into that sleep from which there is no awakening and a number of the other creatures disappeared. The children finally concluded that the latter had gone to sleep in the ground. The grasshoppers and the tree-toads were the last to take their rest, but just before they answered Mother Nature's call to slumber, a large garden toad came to bear them company.

He was a very interesting toad for he bore signs of having lived through what must have been almost a tragedy. He had lost the lower half of one front leg and had the scar of a long gash on his throat. These disfigurements did not cause him the least unhappiness for he had a very bright wide-awake expression and was as plump and complacent as a toad should be. The loss of his leg caused him a little inconvenience for he sometimes lost his balance when hopping and fell on his back. He occasionally found it difficult to right himself at once but a few vigorous kicks and jumps generally placed him right side up. Three days after he became a member of the terrarium community, he, too, heard Mother Nature's call to bed, and partially buried himself. Each day he covered himself more completely until finally only the top of his head and two sleepy eyes were to be seen. One day, about a week afterward, he disappeared entirely. He proved to be a very restless sleeper, and frequently showed himself during the sunniest parts of nearly every day all winter, occasionally coming entirely out of his earthy covering. He served as a sort of barometer all winter, appearing and disappearing according to bright or gloomy weather. He never, however, left the spot he had chosen for his bed.

"Winter is the night of the year," and the little terrarium world indoors exemplifies it as truly as the great fields of Nature's domain out of doors. The soil is dry and hard in this miniature world and the verdure has dried down to palest green and brown. In its earthy bed, the caterpillars, beetles, and other creatures, lie cosily asleep, and with the masses of tiny eggs, await the vivifying touch of spring.

PLANTING A PLANT.

L. H. BAILEY.

MOST persons are interested in plants, even though they do not know it. They enjoy the green verdure, the brilliant flower, the graceful form. They are interested in plants in general. I wish that every person were interested in some plant in particular. There is a pleasure in the companionship merely because the plant is a living and growing thing. It expresses power, vitality. It is a complete, self-sufficient organism. It makes its way in the world. It is alive.

The companionship with a plant, as with a bird or an insect, means more than the feeling for the plant itself. It means that the person has interest in something real and genuine. It takes him out of doors. It invites him to the field. It is suggestive. It inculcates a spirit of meditation and reflection. It enables one to discover himself.

I wish that every child in New York State had a plant of its own and were attached to it. Why cannot the teacher suggest this idea to the pupils? It may be enough to have only one plant the first year, particularly if the pupil is young. It matters little what the plant is. The important thing is that it shall be alive. Every plant is interesting in its way. A good pigweed is much more satisfactory than a poor rosebush. The pupil should grow the plant from the beginning. He should not buy it ready grown, for then it is not his, even though he own it.

It is well to begin with some plant that grows quickly and matures early. One is ambitious in spring, but his enthusiasm may wither and die in the burning days of summer. If possible, grow the plant

in the free open ground; if this is not feasible, grow it in a pot or box or tin can. Take advantage of the early spring enthusiasm. Choose hardy and vigorous plants; sow the seeds when the "spirit moves."

If one is interested in kitchen-garden vegetables, recommend lettuce and radish or a potato. If in flowers, suggest sweet pea, bachelor's button or blue-bottle, annual phlox, candytuft. If in fruits, suggest strawberry.

* * *

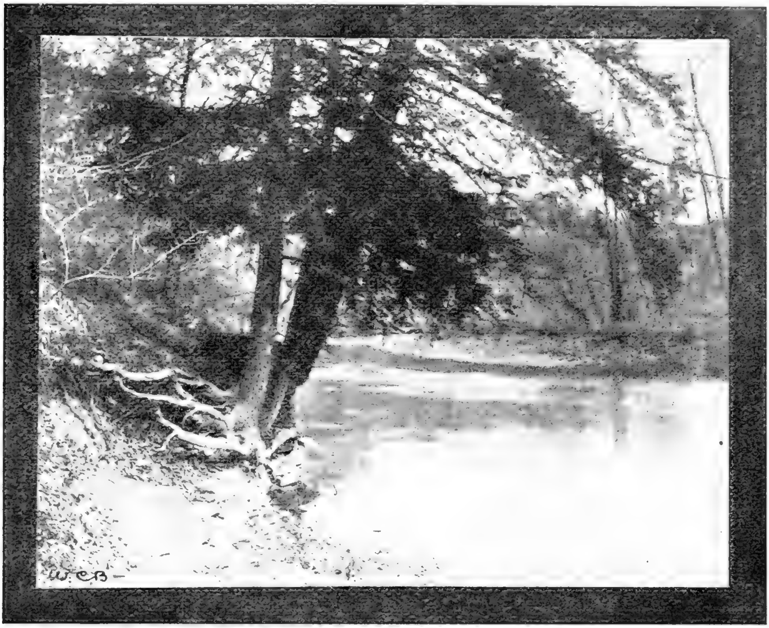
We desire to inaugurate a general movement this spring for the planting of plants. The school ground should be planted. Private yards should be planted. Roadsides should be planted. In some cities and villages there are committees or other organizations whose object it is to encourage planting of public and private places. Sometimes this organization is connected with the school interest, sometimes with a local horticultural or agricultural society, sometimes with a business men's organization. There should be such a committee in every village and town. We wish that the teachers might help in this work, for they would not only be lending their aid to planting, but would be interesting their pupils in some concrete and useful work, and would teach them the value of public spirit. Arbor day should be more than a mere ceremonial. It should be a means of awakening interest in definite plans for the adornment of the neighborhood and in directing the attention of the children nature-ward.

The Bureau of Nature Study will be glad to aid in any such movement in the State, so far as it may be able. We shall be glad to suggest kinds of plants, methods of organization, and the like. We have issued several papers on planting, and these are now available: Bulletin 122, "Hints on the Planting of Shrubbery;" Bull. 160, "Rural School Grounds;" Bull. 161, "Annual Flowers;" Nature-Study Leaflet No. 4, "A Children's Garden;" Leaflet No. 15, "A Handful of Soil" (Part 2).

A 5. May, 1901.

CORNELL
NATURE-STUDY QUARTERLY

No. 9.



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A CHAT WITH THE READER.

THIS issue is intended to complete the publication of the Nature-Study Quarterly and the Teachers' Leaflets. It is an opportune time, therefore, to have a confidential chat with the reader.

WHY THE PUBLICATION CEASES.

We cease the publication of this Quarterly because we feel that we now have sufficient Leaflets to enable us to prosecute our mission with efficiency, and because we desire to utilize our funds and energies to intensify the work that is now in progress. We began the publication of the Leaflets because we had no literature that seemed to be adapted to our needs. It has never been our purpose to continue the publication of Leaflets indefinitely. We wanted to make a sufficient number to cover a fairly wide range of subjects, and thereby to suggest useful topics and live methods for the needs of teachers in all parts of the State and under various conditions. These publications, begun in 1896, now comprise lessons on about 30 topics. These topics are sufficient in number to enable any teacher to choose lessons for a year's work, or to suggest related lines of inquiry. These Leaflets are to be kept in print. They are a part of our working capital. The more they are used the more useful they will be. Every year the teacher has new pupils. It is easier for the teacher to instruct in the old and familiar topics than to feel that he is obliged to take up new ones each year. We hope that many new topics will be taken up, for a novel subject often renews the zeal of the teacher; but the teacher who can use these Leaflets can easily work out other subjects for himself, and we shall be glad to help him with personal suggestions. We fear that to continue to publish Leaflets would be to dissipate our efforts rather than to centralize and intensify them.

A Turning Point in Our Work.

We feel that we have now come to the close of the first epoch in our nature-study work. So far the effort has been largely a propagandist movement. The work was new. By every legitimate means it must be brought to the attention of the school teachers in New York State. It must be advertised.

This preliminary work has now been largely done. Probably every teacher in the State has heard of the work, directly or indirectly. Not all teachers desire to take up nature-study work. It is not desirable that all of them, nor perhaps even half of them, should undertake it. Nature-study must take its place and chances with other school work. We have had an opportunity to discover those persons who desire to work in nature-study lines. With these persons we desire to come into closer contact, adding to our list all those who feel that they are called to teach these subjects. We want to give more direct and personal help. We want to extend and increase the work by intensifying it rather than by spreading it. We feel that our most serious and effective work has only just begun.

Is Nature-Study on the Wane?

Real nature-study cannot pass away. We are children of nature, and we have never appreciated the fact so much as we do now. But the more closely we come into touch with nature the less do we herald the fact abroad. We may hear less about it, but it will be because we are living nearer to it and have ceased to feel the necessity of advertising it.

Much that is called nature-study is only diluted and sugar-coated science. This will pass. Some of it is mere sentimentalism. This also will pass. With the changes the term nature-study may fall into disuse; but the name matters little so long as we hold to the essence.

All new things must be unduly emphasized, else they cannot gain a foothold in competition with things that are established, For a day, some new movement is announced in the daily papers. and then, because we do not see the head lines, we think that the movement is dead; but usually when things are heralded they

have only just appeared. So long as the sun shines and the fields are green, we shall need to go to nature for our inspiration and our respite; and our need is the greater with every increasing complexity of our lives.

What is Nature-Study?

It is a point of view. It is the acquirement of sympathy with nature, which means sympathy with what is.

As a pedagogical ideal, nature study is teaching the youth to see and to know the thing nearest at hand, to the end that his life may be fuller and richer. Primarily, nature-study, as the writer conceives it, is not knowledge. He would avoid the leaflet that gives nothing but information. Nature study is not method. Of necessity each teacher will develop a method; but this method is the need of the teacher, not of the subject.

Nature-study is not to be taught for the purpose of making the youth a specialist or a scientist. Now and then, a pupil will desire to pursue a science for the sake of the science, and he should be encouraged. But every pupil may be taught to be interested in plants and birds and insects and running brooks, and thereby his life will be the stronger. The crop of scientists will take care of itself.

It is said that nature-study teaching is not thorough and therefore is undesirable. Much that is good in teaching has been sacrified for what we call "thoroughness," — which in many cases only means a perfunctory drill in mere facts. One cannot teach a pupil to be really interested in any natural object or phenomenon until the pupil sees accurately and reasons correctly. Accuracy is a prime requisite in any good nature-study teaching, for accuracy is truth and it develops power. It is better that a pupil see twenty things accurately, and see them himself, than that he be confined to one thing so long that he hates it. Different subjects demand different methods of teaching. The method of mathematics cannot be applied to dandelions and polliwogs.

The first essential in nature-study is to see what one looks at. It is positive, direct, discriminating, accurate observation. The second essential is to understand why the thing is so, or what it means. The third essential is the desire to know more,— and this comes of

itself and thereby is unlike much other effort of the schoolroom. The final result should be the development of a keen personal interest in every natural object and phenomenon.

So far as possible, nature-study should be spontaneous. To make it a formal part of school work, leading to perfunctory examinations, is to take the life out of it. We do not expect that the Leaflets will be used as texts. They are merely suggestions to teachers, designed to indicate the kinds of subjects that may be taken up with profit, to give subject-matter, and to point a way in which the subject may be taught.

The Purpose of Our Work.

To improve agriculture is the purpose of our nature-study work. We believe that the most fundamental thing we can do is to give a new enthusiasm and a new point of view to the coming farmer. Nor do we hold that the coming farmer alone should be reached in order that farming be improved; we want to do something to elevate the tone of country living, and this can be done only when a general public sentiment is awakened. No longer is the farmer a man by himself; he is a man among men.

Our work is maintained by a State appropriation, given for the extending of agricultural knowledge. There are several lines of work conducted under the auspices of this State law, of which the nature-study movement is one. A coördinate movement is the Farmers' Reading-Course, in which nearly 30,000 New York farmers are now enrolled. A Reading-Course for Farmers' Wives is lately established, and about 6,000 women are enrolled in it. The literature which all these people read is prepared and furnished by the College of Agriculture. The Farmers' Reading-Course extends through three years, six Lessons being taken up each year. The eighteen Lessons comprise series on

The soil,
Animal husbandry,
Orcharding.

The Lessons are elementary statements of principles, with applications to the familiar work of the farmer. It is now proposed to intro-

duce these Lessons as texts into such rural schools as desire to take up distinctly agricultural work, and this endeavor has been approved by Hon. Charles R. Skinner, Superintendent of Public Instruction.

While we desire to reach all the schools with the purpose of improving country life, we do not believe it to be wise to make the teaching of technical agriculture compulsory in any school, not even in the rural districts. To force the teaching of agriculture is to make it perfunctory and of no avail. The teacher must be trained. Public sentiment must be awakened. A desire must be created. It is a question whether any technical or professional work should be introduced into the elementary schools; but it is always advisable to awaken the pupil's interest in the things with which he lives.

How to make the rural school more efficient is one of the most difficult problems before our educators, but the problem is larger than mere courses of study. Social and economic questions are at the bottom of the difficulty, and these questions may be beyond the reach of the educator. A correspondent wrote us the other day that an old teacher, in a rural school, who was receiving $20 a month, was underbid 50 cents by one of no experience, and the younger teacher was engaged for $19.50, thus saving the district for the three months' term the sum of $1.50. This is an extreme case, but it illustrates one of the rural school problems.

One of the difficulties with the rural district school is the fact that the teachers tend to move to the villages and cities, where there is opportunity to associate with other teachers, where there are libraries, and where the wages are sometimes better. This movement is likely to leave the district school in the hands of younger teachers, and changes are very frequent. To all this there are many exceptions. Many teachers appreciate the advantages of living in the country. There they find compensations for the lack of association. They may reside at home. Some of the best work in our nature-study movement has come from the rural schools. We shall make a special effort to reach the country schools. Yet, it is a fact that new movements usually take root in the city schools and gradually spread to the smaller places. This is not the

LEAFLET.

No. 14. A Summer Shower. June, 1899. *Ralph S. Tarr.*
Junior Naturalist Leaflet No. 3. "Little Hermit Brother." (Cicada Septendecim.) *Anna Botsford Comstock.*
Notes for Junior Naturalists. *Jno. W. Spencer.*
Cornell Junior Naturalist Clubs.
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Notes.
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No. 18. A Brook. June, 1900. *L. H. Bailey.*
I. A Brook and Its Work. *J. O. Martin.*
II. Insect Life of a Brook. *Mary Rogers Miller.*
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No. 19. How Plants Live Together. October, 1900. *L. H. Bailey.*
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Leaflet.

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Planting a Plant. *L. H. Bailey.*
(Nature-Study Quarterly No. 8.)

No. 22. A Chat with the Reader. *L. H. Bailey.*
Spiders. May, 1901. *John Henry Comstock.*
List of the Teacher's Leaflets and Related Literature.
(Nature-Study Quarterly No. 9.)

Lessons in the Farmers' Reading-Course.

Series A. The Soil and the Plant.

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2, " Tillage and Underdrainage: Reasons why. December, 1900. *J. W. Spencer* and *John Craig.*
3, " Fertility of Soil: What it is. January, 1901. *G. W. Cavanaugh.*
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6, " Problem of Impoverished Lands; With Answers to Questions on previous five lessons. December, 1900. *L. H. Bailey, H. P. Gould.*

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16, " Orcharding: Review with answers to questions on previous five lessons. 1901. *John Craig.* (In preparation.)

Farmers' Wives' Reading-Course.

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2. Home Sanitation. April, 1901. *Martha Van Rensselaer.*

SPIDERS.

BY JOHN HENRY COMSTOCK.

OF all of our little neighbors of the fields there are none that are more universally shunned and feared than spiders, and few that deserve it less. There is a wide-spread belief that spiders are dangerous, that they are liable to bite, and that their bites are very venomous. Now this may be true of certain large species that live in hot countries; but the spiders of the Northern United States are practically harmless.

It is true, spiders bite and inject venom sufficient to kill a fly into the wound made by their jaws. But they are exceedingly shy creatures, fearing man more than they are to be feared. If an observer will refrain from picking up a spider there is not the slightest danger of being bitten by one; and excepting a single uncommon species no spider is known in this part of the country whose bite would seriously affect a human being.

On the other hand, spiders do much to keep in check various insect pests, and hence must be regarded as our friends. It is, however, from a different point of view that we wish to look upon them at this time. It is as illustrations of remarkable development of instinctive powers, and of wonderful correlation of structure and habit, that we would have the reader study these creatures. The teacher of nature-study can find no more available or more fertile field from which to take subjects for interesting children in the world about us. Let us then put aside our fears and go into the fields and see if we learn something of the ways of these spinners.

THE FUNNEL-WEB WEAVERS.

Often on summer mornings the grass of the roadsides and fields is seen to be carpeted with little sheets of glistening silk, the webs of the grass-spider. None were observed the day before; and we wonder at the sudden appearance of this host of weavers. Later

in the day the webs have vanished! Have the weavers rolled them up and carried them off? We remember that there was an especially fine one near the end of the veranda steps; we examine the place carefully and find that it is still there, but not so conspicuous as it was. The warm sun has dissipated the dew which rendered visible to our dull eyes the tapestry of the fields. Now that our eyes are opened we can find the webs everywhere and are impressed with a suspicion that perhaps ordinarily we see very little of what is around us.

We examine one of the webs carefully and find that it is a closely woven sheet made of threads running in all directions; that it is attached to spears of grass, and supported by numerous guy lines, and that from one side a funnel-like tube extends downwards. If, while we are watching, an insect alights on the sheet there darts from the tunnel, where she was concealed, the owner of the web, a dark-colored spider; and the insect must be agile if it escapes.

If you attempt to catch the spider it retreats to its tunnel; and when you examine the tunnel the spider is not there. You find that the tube is open below, that there is a back door by which the spider can escape when hard pressed.

We call those spiders that make webs of this kind *The Funnel-web Weavers.* They are long-legged brown spiders, which run on the upper surface of their webs; these are usually made on grass, but sometimes they are found in the angles of buildings, and in quite high places.

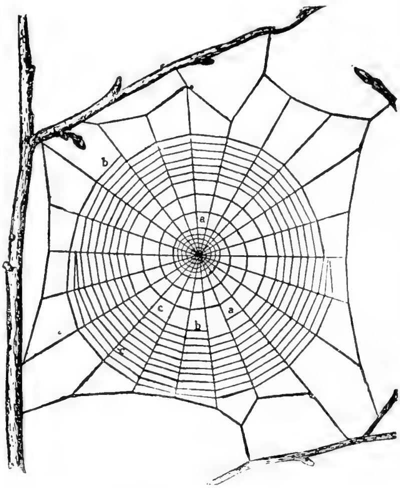
The Cobweb Weavers.

The webs that we most often find in the corners of rooms are of a different kind and are made by the members of a family known as *The Cobweb Weavers.* In these webs there is not such a definite sheet of silk as in those of the funnel-web weavers, but instead a shapeless maze of threads extending in all directions. Many of the cobweb weavers, however, make their webs in the fields on bushes, and weave in them a flat or curved sheet, under which the spider hangs back downward. The funnel-web weavers run right side up, the cobweb weavers hang inverted. Some of the cobweb weavers do not remain in the webs, but have a nest in a

neighboring crack or corner, from which they rush to seize their prey, and sometimes there is a funnel-shaped tube leading to their nest. But these spiders differ from the true funnel-web weavers in running back downwards on the lower side of their webs.

The Orb Weavers.

The spider webs that most often excite admiration are those in which the supporting threads radiate from a center like the spokes of a wheel, and bear a spiral thread. Such webs are known as orb-webs; and the family of spiders that make them, *The Orb Weavers.*



115. - *Nearly completed orb-web.*

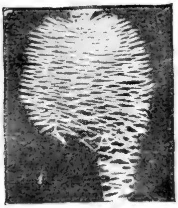
Few if any of the structures built by lower animals are more wonderful than these webs; but they are so common that they are often considered hardly worthy of notice. If they occurred only in some remote corner of the earth, every one would read of them with interest.

The webs or nets of the different species of orb weavers, differ in the details of their structure; but the general plan is quite similar. There is first a framework of supporting lines. The outer part of this framework is irregular, depending upon the position of the objects to which the net is attached; but the central part is very regular, and consists of a number of lines radiating from the center of the net (Fig. 115). All of these supporting lines are dry and inelastic. Touch them with your pencil and you find that they neither stretch nor adhere to it. Upon these radiating lines there is fastened in a very regular manner a thread which is sticky and elastic. This will adhere to your pencil, and will stretch several times its normal length before breaking. Usually this sticky thread is fastened to the radiating lines so as to form a spiral; but a few species make

nets in which it is looped back and forth. And even in the nets where the greater part of the thread is in a spiral there are in most cases a few loops near the lower margin (Fig. 115). Examine the next orb-web you will find and see if it is true in that case.

Many of the orb weavers strengthen their nets by spinning a zigzag ribbon across the center. This ribbon is made by spreading apart the spinnerets, the organs from which the silk is spun, and which will be described later. Ordinarily the tips of the spinnerets are held close together so that they form a single thread, but by spreading them apart many threads can be spun at once, thus forming a ribbon.

Some orb weavers are not content with making a simple zigzag band across the center of the net, but weave an elaborate bit of lace in this position. Figure 116 is from a photograph of the center of the net of one of these spiders, which was found near Ithaca.



116.—*Lace-like hub of an orb-web.*

In studying the various kinds of orb-webs one should pay particular attention to the center of the web; for this part differs greatly in the webs of the different species. There is usually a *hub* composed entirely of dry and elastic silk woven in an irregular manner; outside of this there are several turns of a spiral thread, which is also dry; this constitutes the *notched zone*, a name suggested by the fact that the spiral line is attached for a short space to each radius it crosses, thus giving the line a notched course. In many cases it is here, on the hub and the notched zone, that the spider waits for its prey; and it is obvious that sticky silk in this place would be objectionable. Between the notched zone and the *spiral zone*, the part furnished with the sticky spiral thread, there is a clear space, the *free zone*, crossed only by the radii. This gives the spider an opportunity to pass from one side of the web to the other without going around the entire web.

Some orb weavers do not wait upon the hub, but have a retreat near one edge of the net, in which they hang back downwards. While resting in these retreats they keep hold of some of the lines

leading from the net, so that they can instantly detect any jar caused by an entrapped insect.

When an insect in its flight touches one of the turns of the sticky line, the line adheres to it, but it stretches so as to allow the insect to become entangled in other turns of the line. If it were not for this elasticity of the sticky line most insects could readily tear themselves away before the spider had time to reach them.

In running over its net, the spider steps upon the radii, carefully avoiding the sticky line; otherwise it would destroy its own net. The rapidity with which a spider can cross its net without touching the sticky line is remarkable.

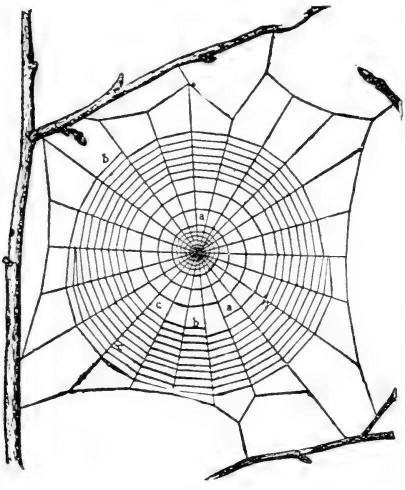
In making its web an orb weaver first spins a number of lines extending irregularly in various directions about the place where its orb is to be; this is the outer supporting framework. Often the first line spun is a bridge between two quite distant points, as the branches of two separate bushes. How did the spider cross the gulf? It has no wings.

The bridge building can be easily seen on a warm summer evening, the time at which the spiders are most active repairing their old nets and building new ones. The spider lifts the hind end of its body, and spins forth a thread; this is carried off by the wind, until finally striking some object it becomes fast to it. The spider then pulls in the slack line, like a sailor, and when the line is taut fastens it to the object on which it is standing, and the bridge is formed.

After making the outward framework, the radiating lines are formed. A line is stretched across the space so as to pass through the point which is to be the center of the orb. In doing this the spider may start on one side, and be forced to walk in a very roundabout way on the outer framework to the opposite side. It carefully holds the new line up behind it as it goes along, so that it shall not become entangled with the lines on which it walks; one or both hind feet serve as hands in these spinning operations; for as the spider has eight feet, it can spare one or two for other purposes than locomotion. When the desired point is reached the slack is pulled in and the line fastened. The spider then goes to the point where the center of the orb is to be, and fastening another

line, it walks back to the outer framework and attaches this line an inch or two from the first. In this way all of the radiating lines are drawn. The next step is to stay these radii by a spiral line, which is begun near the center, and attached to each radius as it crosses it. The turns of this spiral are as far apart as the spider can conveniently reach.

All of the threads spun up to this stage in the construction of the web are dry and inelastic. The spider now proceeds to stretch upon this framework a sticky and elastic line, which is the most important part of the web, the other lines being merely a framework to support it. In spinning the sticky line, the spider begins at the outer edge of the orb, and passing around it fastens this line to each radius as it goes. Thus a second spiral is made. The turns of this spiral are placed quite close together, and the first spiral, which is merely a temporary support, is destroyed as the second spiral progresses. Figure 117 represents a web in which the second spiral is made over the outer half of the radii. In this figure, *aa*, represents the temporary stay-line; *bb*, the sticky spiral; and *cc*, the fragments of the first spiral hanging from the radii.

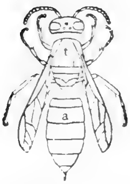


117.—*Nearly completed orb-web.*

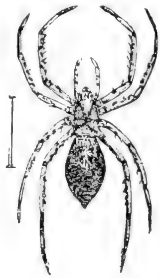
The Parts of a Spider.

Spiders differ much in appearance from the true insects. In the insects the body is composed of three regions: the head, the thorax, to which the legs are attached; and the abdomen or hind body (Fig. 118). In the spiders the head and thorax are grown together, forming a region which is known as the *cephalothorax;* to this the *abdomen* is joined by a short, narrow stalk (Fig. 119). Spiders differ also from insects in the number of their legs, spiders having eight legs and insects only six.

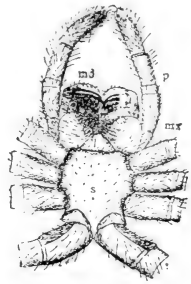
Spiders have two pairs of jaws, which, except in the Tarantula family, move sideways like the jaws of insects. The first pair of jaws are called the *mandibles*. Each mandible consists of two segments, a strong basal one and a claw-shaped terminal one, at the tip



118.—*Wasp, with head, thorax and abdomen separated.*

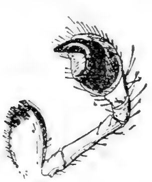


119.—*Spider, showing division of the body into cephalothorax and abdomen.*



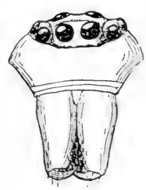
120.—*Lower side of cephalothorax of a spider;* md, *mandible;* mx, *maxilla;* p, *palpus;* l, *lower lip;* s, *sternum.*

of which the poison gland opens (Fig. 120). The second pair of jaws are known as the *maxilla*. These are situated just behind the madibles, one on each side of the mouth. Each maxilla bears a large feeler or *palpus*. These palpi vary greatly in form; frequently, especially in females, they resemble legs; hence many spiders appear to have five pairs of legs. In the male spiders the last segment of the palpus is more or less enlarged, ending in a complicated knob-like structure (Fig. 121). It is thus easy to determine the sex of a spider by merely examining the palpi.



121.—*Maxilla and palpus of male house spider.*

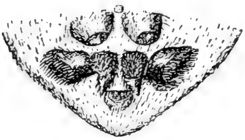
The greater number of spiders have four pairs of eyes (Fig. 122), but there may be only one, two, or three pairs; and certain cave spiders are blind. The eyes appear like little gems set in the front of the cephalothorax. They are most prominent in the jumping spiders, which stalk their prey on plants, logs, fences, and the sides of buildings.



122.—*Head of spider, showing eyes and mandibles.*

The most characteristic feature of spiders is their spinning organs. The silk is secreted in glands within the abdomen; and while in the body it is a fluid. It passes out through the *spinnerets*, which are situated near the hind end of the abdomen. There are two or three pairs of spinnerets. These are more or less finger-like in form, and sometimes jointed (Fig. 123). Upon the end of each spinneret there are many small tubes, the *spinning tubes* (Fig. 124), from which the silk is spun. Some spiders have as many as one hundred and fifty or two hundred of these spinning tubes on each spinneret.

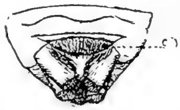
Ordinarily the tips of the spinnerets are brought close together, so that all of the minute threads that emerge from the numerous spinning tubes unite to form a single thread. Hence this tiny thread, which is so delicate that we can see it only when the light falls on it in a favorable way, is composed of hundreds of threads. It is not like a rope, composed of separate strands; for all the minute threads fuse together into a single thread. The change in the



123.— *Spinnerets of a spider.*

124. — *A group of spinning tubes.*

125.— *Viscid silk from an orb-web.*

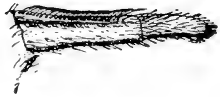


126.— *Spinnerets and cribellum of a curled-thread weaver.*

silk from a fluid to a solid cord, strong enough to support the weight of the spider, must take place quickly after the silk comes in contact with the air on leaving the spinning tubes; the minute size of the threads coming from the spinning tubes doubtless facilitate this change.

Sometimes a spider will spread its spinnerets apart, and thus spin a broad ribbon-like band. We have seen a spider seize a large grasshopper which was entangled in its web, and rolling it over two or three times, completely envelop it in a sheet of silk spun from its spread apart spinnerets. We have already described bands spun by orb weavers across the hub of the net in this way.

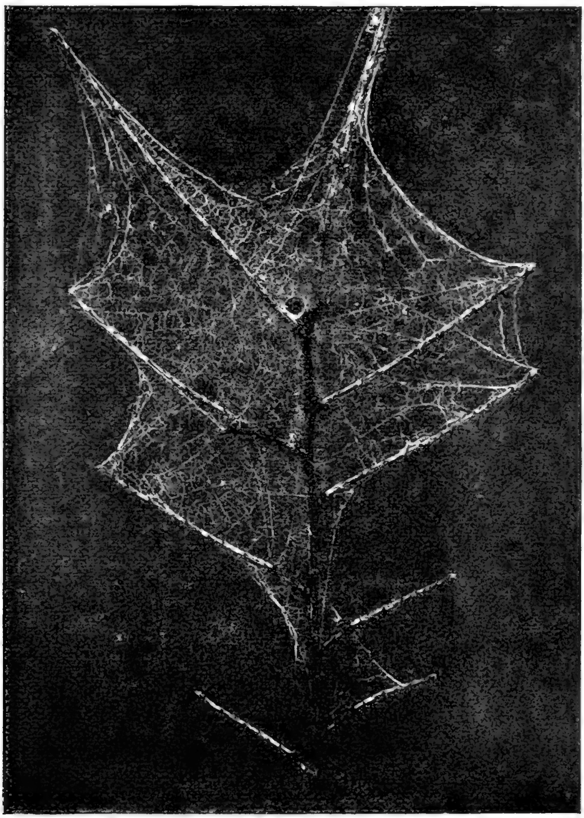
It is supposed that the two kinds of silk spun by the orb weavers are spun from different spinnerets, and that the viscid silk comes from



127.— *Last two segments of hind leg of spider, showing calamistrum.*

the front pair. When this silk is first spun, the viscid matter forms a continuous layer of liquid on the outside of it. But very soon this layer breaks up into bead-like masses— in a way similar to that in which the moisture on a clothes-line on a foggy day collects into drops (Fig. 125).

There are two families of spiders that have spinning organs differing from those of all other spiders. They have



128.— *Web of a curled-thread weaver.*

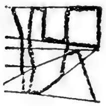
in front of the usual spinnerets an additional organ, which is named the *cribellum* (Fig. 126, c). This bears spinning tubes like the

other spinneret, but these tubes are much finer. These spiders have also on the next-to-the-last segment of the hind legs one or two rows of curved spines; this organ is the *calamistrum* (Fig. 127). By means of the calamistrum these spiders comb from the cribellum a band of loose threads which form a part of their webs.

The Curled-thread Weavers.

The spiders possessing a cribellum and a calamistrum represent two families, one of which makes irregular webs; the other, those which are of definite form.

An irregular web of a curled-thread weaver is shown in Fig. 128 from a photograph. In this web the framework is of ordinary silk; and upon this framework is placed a band of curled or tangled threads (Fig. 129). An insect alighting on a net of this kind is likely to get its feet caught in the tangled silk, and to be held in fast till the spider can pounce upon it. Nets of this kind are found on bushes and on the sides of buildings.

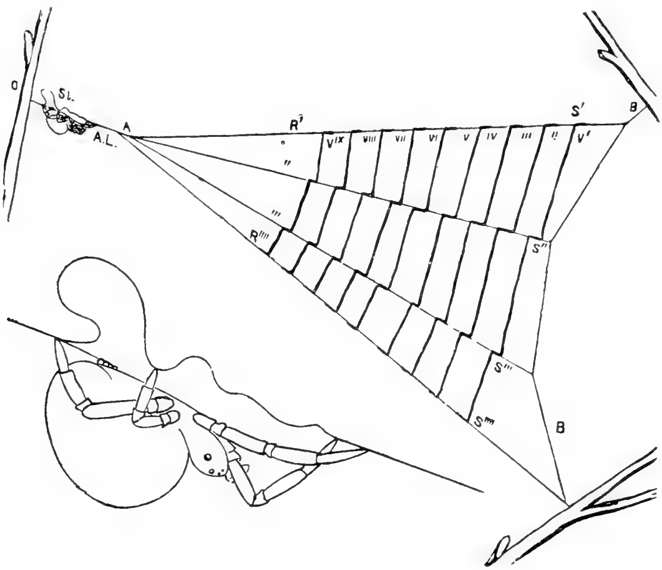


129.—*Fragment of a curled-thread weaver's web, enlarged.*

There are two quite distinct types of regular webs made by spiders possessing a cribellum and a calamistrum. One is a round web which resembles at first sight those of the orb weavers; but it differs from the ordinary orb-web in that the spiral thread is made of curled or hackled silk. These webs are nearly horizontal, and are usually made between stones or in low bushes; they are not common.

The other type is represented by the web of the Triangle Spider. This web is most often found stretched between the twigs of a dead branch of pine or hemlock. At first sight it appears like a fragment of an orb-web (Fig. 130); but a little study will show that it is complete. The accompanying figure, by Dr. B. G. Wilder, who first described the habits of this spider ("Popular Science Monthly," 1875), illustrates the form of the web. It consists of four plain lines corresponding to the radiating lines of an orb-web, and a series of cross lines, which are spun by the cribellum and calamistrum. Each cross line is composed of two lines about $\frac{1}{500}$ of an inch apart. These double lines take the place of the

curled threads woven by other members of the family to which the triangle spider belongs. From the point where the radiating lines meet a strong line extends to one of the supporting twigs. Near this twig the spider rests, pulling the web tight so that there is some loose line between its legs, as shown in the enlarged figure. When an insect becomes entangled in one of the cross lines, the spider suddenly lets go the loose line so that the whole web springs forward, and the insect is entangled in other cross lines. The spider then



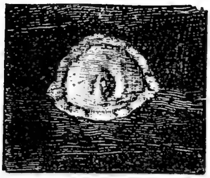
130.—*Web of the Triangle Spider.*

draws the web tight and snaps it again. This may be repeated several times before the spider goes out upon the web after its prey.

The triangle spider is a tiny fellow, and so closely resembles the color of the dead branch near which it rests that it is very difficult to find; its web is more easily seen, though it usually requires careful searching to discover it.

The Motherhood of Spiders.

As a rule young spiders are forced to shift for themselves, and a very hard time they have; but of this we have not space to write.



131.—*Egg-sac of a spider.*

With spiders, the mother's care is devoted chiefly to furnishing protection to her helpless eggs. These are placed in silken sacs, which are often very elaborate in construction and protected with great care.

The most common egg-sacs are those found in the fields attached to stones and pieces of wood (Fig. 131). They are disk-shaped objects, silvery in color, and about the size of an old-fashioned three cent piece.

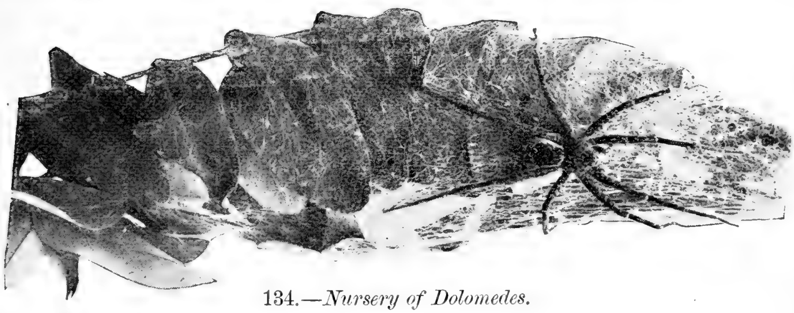
132.—*Egg-sac of an orb weaver.*

The egg-sacs of the cobweb weavers can be found suspended in their webs; and those of the orb weavers in various situations. Figure 132 represents the large egg-sac of one of the orb weavers.

This is made in the autumn, and contains at that season a large number of eggs — five hundred or more. These eggs hatch early in the winter; but no spiders emerge from the egg-sac until the following spring. If egg-sacs of this kind be opened at different times during the winter, the spiders will be found to increase in size but diminish in numbers as the season advances. In fact a strange tragedy goes on within these egg-sacs: the stronger spiders calmly devour their weaker brothers, and in the spring those that survive emerge sufficiently nourished to fight their battles in the outside world.

133.—*Lycosa and egg-sac.*

The females of the *Running Spiders* not only make a carefully constructed egg-sac, but also care for the young spiders for a time. The running spiders are the large, dark-colored, hairy spiders, often found under stones and rubbish; they are so called because they capture their prey by running. The females of most of the species (those of the genus *Lycosa*) drag after them their egg-sac, which is attached to the spinnerets (Fig. 133); and when the young hatch, they climb on their mother's back, and are carried about for a time.



134.—*Nursery of Dolomedes.*

One of the running spiders (*Dolomedes*) carries her egg-sac with her mandibles until the young are ready to emerge. At this time the mother fastens the egg-sac in a bush, and spins irregular threads about it, among which the young spiders remain for a time (Fig. 134). In the specimen figured the egg-sac was concealed in the upper part of the web.

The Ballooning Spiders.

In warm autumn days, innumerable threads can be seen streaming from fences, bushes, and the tips of stalks of grass, or floating through the air. These are made by the *Ballooning Spiders*, which are able to travel long distances, hundreds of miles, through the air by means of these silken threads.

The ballooning spider climbs to some elevated point, and then, standing on the tips of its feet, lifts its body as high as it can, and spins out a thread of silk. This thread is carried up and away by a current of air. When the thread is long enough the force of the air current on it is sufficient to bear the spider up. It then lets go its hold with its feet and sails away. That these spiders travel long distances in this manner has been shown by the fact that they have been seen floating through the air at sea far from land.

CORNELL READING-COURSE FOR FARMERS.

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READING-LESSON

NO. 10.

MARCH, 1901.

BY JOHN CRAIG.

SOILING CROPS AND SILAGE.

Fodders which are grown to be fed to domestic animals in a green uncured condition are called soiling crops.— The growing of soiling crops is a fairly well established practice in the principal dairying sections of the State. It might be greatly extended with profit to all farmers who follow dairying or mixed husbandry. A soiling crop is another name for a green food; complete soiling is practiced when cattle are housed or confined in yards and fed on green feed raised for this purpose; these crops are also used to supplement the pasture forage which usually becomes limited in quantity and tough in quality on the advent of hot dry midsummer weather; in this case the system is called "half soiling."

By soiling, more cattle may be kept on a farm than if the land is kept in pasture and meadow.— Experiments have demonstrated that by the judicious use of soiling crops twice and perhaps three times as many cattle can be kept on a given piece of land as the same piece will support when soiling methods are not employed. Under the most intensive soiling systems the cattle are housed and the food cut and carried to them; another plan is to feed them in a yard or lot; a third allows them to graze on a part of the field till the available food is consumed, when another area is thrown open. The method a farmer should choose will depend on the kind of crops and the class of animal. The chief thing is to economize food and labor. It is probable that the owner will administer the food supply more economically than the animal. It would obviously be bad management and poor economy to turn a herd of steers into an acre of growing corn — probably more corn fodder would be

destroyed than eaten — but if allowed to graze in a field of rape and oats for a while each day the results might be very satisfactory. In the case of the rape and oats the loss from tramping would be comparatively light. In the case of the corn the amount saved by cutting and hauling would more than pay for the labor. Soiling is adapted to high priced, easily tilled fertile lands; half soiling methods may be advantageously used under less favorable conditions.

Succulent bulky foods promote the health and increase the milk flow of dairy cows.— In Lesson 7 the term "nutritive" ratio was explained and the reader was told that the food value of a fodder was not completely expressed by its content of albuminoids and carbohydrates. He was told that it is very important that the animal should be supplied with a certain amount of food in bulky coarse form. Food sufficient to maintain the bodily heat of the animal, repair waste of tissues, form new tissue, perform reproductive functions and lay up reserve stores of fat, or produce milk or wool, might be given in concentrated form; but it is more than probable that the health of the animal would suffer. The digestive organs of domestic animals need to be distended so that the digestive fluids secreted may be allowed to act.

Consumption of fodder dependent on succulence and palatability.—When fodder is green and juicy, cattle like it and eat heartily. This is characteristic of spring pastures. When dry weather comes on the herbage loses water, the fibre is less disguised and cattle do not partake so freely; nor is the food so digestible. This is characteristic of some dried fodders, not all, because there is a striking difference between a *dried* fodder and a *cured* fodder. Many farmers take pains to cure their clover and timothy before housing it instead of simply drying it. But the curing of hay is another story. The growing of soiling crops then supplements the more or less dried pastures of summer and autumn with palatable and succulent green fodder; and by the aid of the silo we may preserve these fodders in their green state for use in the winter.

The plants which may be used for soiling purposes include the majority of forage crops, but corn stands first in importance.—

Soiling crops may be divided into several classes based on the manner of cultivating them. First, the maize and sorghum group, including corn (maize), sorghum, Kaffir corn, milo maize, teosinte and the like; second, the "small grains," as oats, barley and wheat; third, the legumes, comprising the clovers, peas, alfalfa, vetches and soy beans; fourth, members of the cabbage and turnip tribe, as rape, cabbage, to which may be added mangolds and other root crops. Corn is chief among soiling crops, because it grows rapidly and produces more fodder to the acre at a given expense than any other plant. In addition it is readily preserved in a green state in the silo. But it should be supplemented by other crops which may be cut earlier in the season. Corn and the sorghums are southern plants and cannot be planted successfully till the ground is reasonably warm in spring, and do not attain cutting size till midsummer or later. Therefore the farmer who is practicing soiling must provide forage other than corn for the early part of the season. This is done by using such quick growing plants as oats, barley, rye and peas; by sowing rye and wheat in the fall or by employing a legume or grass that will winter successfully and grow rapidly in spring, such as clover, alfalfa, crimson clover, or orchard grass.

Growing the crop.—Corn does best on a warm loam. The soil should be thoroughly and deeply plowed. The surface does not require such careful pulverizing as should be given the field intended for wheat. Plant when the ground is warm.

Formerly nearly all the corn grown for silage purposes was broadcasted. It is true that broadcasting sometimes gives a larger yield than the "hill" or the "row" systems, but practical experience has demonstrated that the yield is at the expense of the nutritive value of the food. Again, during dry seasons, sowed corn is likely to fail because of lack of moisture. If soil is warm and rich, corn for the silo may be grown in rows, but if the conditions are at all unfavorable it should be planted in hills and cultivated both ways. In the northeastern part of the State early varieties should be selected.

As the seed ripens palatability of the stalks decreases.—As to the proper time to cut corn for the silo there is a golden mean. If cut

too young it lacks protein and sugar and contains an excess of moisture. In the process of seed ripening there is a movement of food material from the stalk and leaf to the seed. This causes the fibre of the stalk to become prominent which lessens palatability. When is the proper time to cut? Chemical analysis and practical experience have shown that the right time is when the kernel has hardened, glazed on the outside, and is yet in the "dough" condition in the middle. At this period the stalk and ear are both palatable. Cornell experiments give no food argument for recommending sorghum or other fodders of this class for cultivation in this State. Where they can be grown, corn can also be cultivated and with better results.

Desirable combinations of the cereals with legumes may be made. — Prominent among these combinations is oats and peas. This crop can be sown early and matures for cutting before corn is ready. Again it may be sown as late in this locality as August 1st when it furnishes excellent fall pasturage. Barley and peas are also desirable for fall fodder. For very early spring use rye may be grown and it may be succeeded by oats and peas.

The legumes are not only valuable for producing forage, but are an essential part of a soiling rotation.— Clovers, peas, beans and alfalfa are nitrogen collectors and soil regenerators. One of these should be included in every rotation. Where nitrogen is needed by the soil a legume should be employed, as in following an exhausting crop, or when preceding one that makes heavy demands on nitrogen. When land is seeded to a perennial legume it should be fairly free from weeds. Perennial plants are those which continue to grow for several years from the same root. Thus in following corn or potatoes, "hoed crops," we may expect the land to be reasonably clean. This is also a desirable place to put a legume in the rotation. Lucern or alfalfa is a perennial leguminous plant. It is closely related to the true clovers and is often classed with them. Mammoth red clover usually dies out if not allowed to reseed after the second year, and for this reason is classed with biennial plants. Alsike and common or medium red belong to the same group. Crimson clover, on the contrary, is an annual plant and dies after

perfecting its seed. If sown too late in the summer to blossom before cold weather, it lives over winter in the milder parts of New York State, begins growth in the spring, and completes its growth in the early summer. It is likely to winter kill in central and northern New York unless covered with snow. It stores up nitrogen very abundantly. Clovers when grown alone do not yield as much fodder as mixed cereals, oats and peas for instance; but they are particularly useful when cattle are fed on the "hurdling" system — a modified form of soiling. By this method the animals are only allowed access to a part of the field at a time. Readily movable fences are employed. In this way forage is materially economized.

Hungarian grass and the millets are valuable midsummer soiling crops.— These are heat loving plants; they should not be sown till danger of frost is over. They grow rapidly and under favorable conditions may be ready for cutting in five or six weeks after seeding. In dry seasons they are particularly useful. Millet is an exhausting crop both on the fertility and moisture of the soil, and it is a good plan to follow it with clover.

Certain members of the crucifers, to which group belong turnips, cabbages and radishes, are esteemed as producers of green feed.— The most important member of this group from our present standpoint is rape. This is practically a rutabaga turnip with an excessively leafy top and a fibrous, prongy unswollen root. In the early stages of its growth it is difficult to distinguish it from the rutabaga turnip. There are two ways of growing it: in rows, when it is tilled like turnips; broadcasted and untilled except a light harrowing after it has a firm hold on the soil. When grown in rows it is frequently cut and fed but sometimes pastured; when broadcasted it is nearly always pastured. It is a hardy plant and grows well in the cool weather of late autumn. In may be sown early in spring. Rape is liked by sheep, cattle and horses. When cabbage is as extensively grown as it is in New York excellent use can be made of the soft heads by using them as cattle feed in the autumn. Mangolds produce a large tonnage to the acre and are easily grown. They add greatly to the palatability of dry fodders.

Green foods must be fed with caution.—The succulence and palatability of green foods cause animals to over eat at first, and the rapid fermentation of the green mass in the stomach may result seriously. The animals should not be put on full rations of green food at once. They should be accustomed to it gradually by using it first as supplementary to the regular ration and increasing the amount till the change has been effected.

Summary: The benefit derived from a soiling system may be outlined briefly as follows. The cattle-food producing power of a piece of land may be greatly increased and this food thoroughly utilized; cattle may be kept in excellent condition; weeds may be eradicated; the fertility of the soil may be increased; the cost of fencing may be reduced.

Among the special demands of the system are: increased manual labor and the incident expense; greater skill in providing and supplying a constant and suitable supply of food.

Soiling becomes special farming when it is used exclusively to maintain cattle during summer and requires considerable skill and experience, but as an adjunct to ordinary farm practice it is worthy of trial by all farmers who keep cattle, sheep and hogs.

Silage.

Silage is fodder preserved by means of a silo in a green and succulent condition.—By means of the silo the soiling system is extended throughout the year. Food products are destroyed by germs causing fermentation, decay and putrefaction. If the germs which the substance may contain are killed and other germs are excluded it may be preserved indefinitely. Fruit is heated by the housewife to the boiling point, the germs of ferment are destroyed; the fruit is then enclosed in air tight jars and may be preserved with its original aroma and flavor. Thus the housewife "puts up" in gem jars her winter's supply of fruit. The same principles govern the preservation of the farmer's corn fodder and other soiling crops.

Silage is said to be "sweet" or "sour." Its acidity depends chiefly on the succulence of the plants used and the amount of air contained within the mass.—The germs of ferment can only grow

when supplied with air. In canning fruits the housewife heats the fruit to boiling point for the purpose of destroying germs which cause fermentation and decay. She then seals the fruit in air tight cans. In siloing the farmer constructs an air tight compartment which he fills with chopped green fodder. As soon as this is filled active chemical changes take place which result in generating heat. In the process of fermentation oxygen is consumed and most of the air within the mass is expelled because heating it has increased its volume. When the air has been expelled or consumed, fermentation ceases and if the outside air is then excluded no further change will take place in the quality of the silage. If the plants used in filing the silo are very succulent the excess of water will check the first chemical changes which produce heat necessary to destroy germs of ferment. In this way sour silage is made. It is much less wholesome than sweet silage. It should be stated that there is no formula which will guarantee a specific degree of sweetness and that the terms sweet and sour silage are used in a relative sense. The sweetness of the food depends on the stage to which the first fermentation was carried and the subsequent exclusion of air. The best silage, therefore, can only be made from fairly well ripened plants packed in a practically air tight compartment.

Silos may be built within a barn, or as an addition to a barn; air may be excluded more completely from cylinder shaped silos than from those having corners.—In all silos the greatest waste occurs around the sides, particularly in the corners, because the air has access to these parts. The fodder is not packed tightly in the corners ; the air fills the interspaces and decay results. With the cylindrical silo the friction is equally distributed over the entire inside wall surface so that the silage settles evenly. The place a silo is to occupy may determine the form to select. There are several kinds. Chief among these are the round, the stave, the square or rectangular and the octagonal form. A square or rectangular silo can usually be constructed within a barn with better economy of space than a round silo. For this reason square silos are most frequently employed within the barn and the circular type when a separate building is constructed. The construction of

the stave silo is fully described in Bulletin 167, Cornell Experiment Station.

Feeding silage to dairy cattle.— Well preserved silage is an excellent food for dairy cattle. (Consult Lesson 9.) It should not, however, be used exclusively nor in unlimited quantities. A cubic foot of well packed silage weighs about forty pounds which is considered a sufficient amount for one day for a 1,000 pound cow. Like all green foods it should be fed cautiously at first. At the rate of forty pounds a day, about three and one-half tons of silage would be required to feed one cow for six months; a herd of ten cows would require about thirty-five tons for the same period. Siloists should add one-fourth to the capacity of the silo to make up for the waste which takes place during the feeding period.

To ascertain the capacity of a square or oblong silo, find the cubic contents by multiplying the length by the height and width. This will give practically the number of days which one animal may be fed on this amount; and the time in days it will feed a herd of cattle is easily ascertained by dividing the cubic feet by the number of animals in the herd. To find the capacity of a round silo, its diameter is squared and multiplied by the height; this is multiplied by .7854 which gives the cubic contents. Thus: Diameter 10 feet, height 15 feet; $10 \times 10 = 100 \times 15 = 1500 \times .7854 = 1178.10$ cubic feet; deduct from this one-fourth for waste space and loss of silage in feeding which leaves practically 883 cubic feet of silage for feeding purposes.

Silage plants.— *Corn* is the principal silage plant. It is easy of culture, remarkably productive and is preserved without difficulty. When the earliest ears have reached the "glazed" stage the corn plant is in good condition for the silo. If cut before this it is likely to make sour silage; if cut much later it may mould in the silo. When corn is cut in a very green state it should be wilted somewhat before being put into the silo — the surplus water must be disposed of. If corn is too dry, it may be improved by judicious moistening when the silo is being filled, but uneven wetting causes mould. Clover, oats, peas, barley and mixed crops of these are siloed, but as a rule their use is restricted to summer soiling and corn used for winter feed.

Tight packing assists preservation.— For this reason it is best to cut the plants into short pieces. This is done by means of silage cutters. Where a silo of considerable capacity is to be filled, steam power is preferable, though horse power may serve the purpose. Cornstalks are usually cut into lengths varying from one-half to one and one-half inches. The harder and more fibrous the stalk the shorter should it be cut.

Experience of Cornell University Experiment Station in feeding silage in summer.—The following is by L. A. Clinton, assistant agriculturist of the Experiment Station, written the summer of 1900: "The Cornell University herd consists of 15 cows, which are giving milk at the present time. The pastures upon which these cows were kept dried up, as have all pastures in this vicinity. In the bottom of a large stave silo there remained several feet of good corn silage. The cows were brought to the stable and fed a ration of silage daily. They at once increased their daily milk yield from two to three pounds each. After being fed on silage a few days we cut some oats and peas which had been grown for soiling. These oats and peas were in prime condition, but instead of increasing the milk flow the cows actually fell off in their production. When put back on silage they immediately increased their flow again. While soiling crops are valuable, the necessary work during the busy season is so great, by any soiling system, that many farmers and dairymen do not practice the system. Where silage is fed the heavy work comes late in the season, when other work is well out of the way. No further attention is then required until it is desired to feed the silage."

CORNELL READING-COURSE FOR FARMERS.

QUIZ ON READING-LESSON NO. 10.

MARCH, 1901.

BY JOHN CRAIG.

These questions constitute supplement to Reading-Lesson No. 10 ("Soiling Crops"). Its purpose is to induce the reader to think carefully about what he reads. Answer the questions as best you can and return this sheet to us (2 cents postage). We want these answers in order that we may know what interest you are taking in the Reading-Course and how much good you are getting from it; and we want to help you when you do not understand the problems involved. We are after results, and do not care about the handwriting or the grammar. These answers are for our own examination and are not to be made public. We should be glad of any comments on these lessons. Those who answer the questions will receive future lessons.

When Lesson No. 10 shall have been digested we hope to send you a supplementary Lesson answering questions in all five Lessons in this series and also suggesting how you may find out what fertilizers your soil and crops need.

We have organized a Reading Course for Farmers' Wives. If your wife, mother or sister would like to join this course please send in their names.

1. What do you understand by a soiling crop?

2. To what type of farming is the soiling system best adapted?

3. What are the disadvantages of soiling methods?

4. What are the advantages?

5. How would you prepare your land for a corn crop?

6. What advantages have barley and peas, or oats and peas, over corn as a soiling crop?

7. Why should corn for the silo not be cut while it is green and succulent?

8. Why is it desirable to include peas or clover in the soiling rotation?

9. If you wished a crop that would give you late fall pasturage what plant or plants would you use? Why?

10. Outline a soiling rotation which in your opinion would not impoverish the soil seriously.

11. What is a silo?

12. Explain the principles which govern the preservation of silage.

13. How may the silo be made a part of a soiling system?

14. What experience have you had in soiling?

15. What experience have you had with silage?

Name...

Address...

Date..

CORNELL READING-COURSE FOR FARMERS.

Issued by the College of Agriculture, Cornell University Ithaca, N. Y., in the months of November, December, January, February and March.

READING-LESSON NO. 11.

NOVEMBER, 1900.

BY JOHN CRAIG.

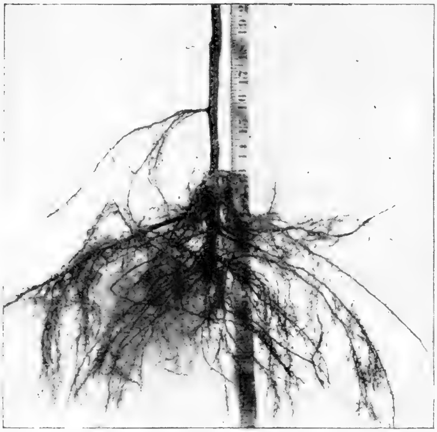
A TREE.

What a noble thing a well-grown and symmetrical tree is! Like an historic building, it is associated with the events of past days and is a part of the country's progress. In it beauty and utility are happily combined. A shapely tree when laden with russet or

1.— *Why not plant an apple tree near the house? How beautiful in spring and how useful in autumn!*

red-cheeked fruit, commands attention not only because of its refined beauty but also for the reason that its products are now recognized among the necessities of life and may readily be exchanged for money. An apple tree therefore appeals to us from the standpoint of sentiment as well as from the dollars and cents point of view. Apple trees are not always profitable. I have seen

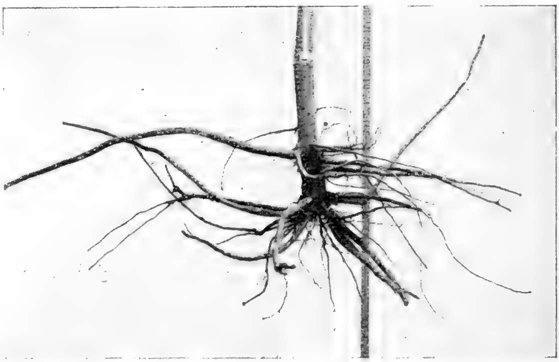
fine fruit trees uprooted because they had not borne satisfactory crops for a few years. In many cases this was a mistake. The failure is oftener due to neglect on the part of the grower than to any fault of the tree. It is the purpose of this series of lessons to discuss the fruit tree and its treatment. Let us first examine the tree itself.



2.— *One year apple tree root graft. Note the fibres and rootlets. These follow the extending roots.*

Parts of the tree.— A glance informs us that a tree is composed of three principal parts, roots, stem (trunk or bole) and the top (called crown by the forester). Each part serves a particular purpose in the economy of the plant's life. Injury to any part results in injury to the entire tree.

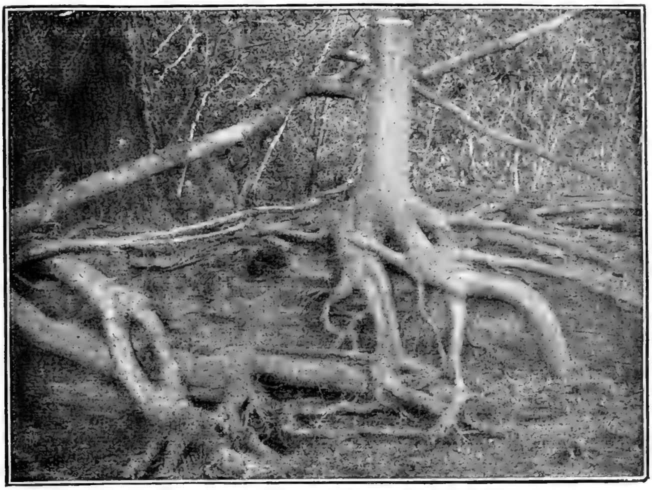
Roots.— These are of three kinds: large woody arms which act as mechanical braces and supports to the tree and hold it erect; rootlets — a small system of roots whose function it is to transmit plant food; and finally root-hairs, tiny foraging agents, which grow on the the rootlets and absorb dissolved plant-food. For a full explanation of how the plant does this, the reader should consult Reading Lesson



3.— *A two year old apple graft, small roots — rootlets, mainly at the ends of the brace roots and left in the ground when tree was dug.*

No. 4. It is important to remember that the small roots are tender and, being small, are readily affected adversely by wind and sun. In transplanting trees always keep the roots covered.

Root growth dependent on character of soil and available plant-food.— If the soil is hard and scantily supplied with plant-food, the growth of root-hairs is naturally restricted; rootlets are few and



4.—*Shallow roots of Hemlocks. Roots exposed by the burning of the leafy mulch. [Pinchot, U. S. Dept. of Agriculture.]*

consequently the number of root-hairs or feeding roots are much lessened. I wonder if you feel inclined to question this statement and to tell me that you have examined the roots of trees growing on poor soil and have found them longer and more spreading than on trees growing in rich ground? This is a good observation and emphasizes the effort that the tree makes to secure food. It should be remembered that the woody roots bear few root-hairs. These root-hairs are found mostly near the ends. The length of the woody root of the tree counts for little therefore. Compare roots of this type with the roots of an elm or willow which have found their way into a tile drain. Great masses of fibres and rootlets characterize these roots. Dissolved nutrients pass along this

miniature water course — the drain — and attract thither the feeding rootlets.

When the tree is transplanted, its growth is dependent in large measure on the physical condition of the soil and the amount of water present. Examine the roots of upturned forest trees. They are often shallow because the subsoil is hard and because there is usually an abundance of food and moisture near the surface. For this reason forest fires burning the ground litter (forest floor), often lay bare the roots of great trees (see Fig. 4). In hard soil the roots of a tree may be confined to a vary limited area for some time, by the planter digging a small hole. In planting an orchard is this wisdom? Gardeners grow large plants very successfully in comparatively small pots, but they take care to supply the plant with an abundance of available plant-food. The farmer finds it cheaper to prepare desirable root pasturage by fining and pulverizing the soil. Try growing carrots or parsnips on hard unstirred soil and compare the product with that grown on deep loam. What about the character of the roots in such cases?

5.—*A pear stem. The bark begins to roughen.*

Stem.— The stem must be preserved intact and healthy in order to facilitate the passage of food both ways. It is the connecting link between the roots and the crown. To the forester the bole (trunk) is the most important part. The larger, longer and cleaner the bole the more valuable is the tree; in other words, the more lumber can be gotten out of it. To the fruit-grower, the stem is important because it supports the crown, and the crown produces the fruit. Without a strong column upon which to build the crown, a good top frame-work cannot be secured. If a block or section is sawed from an apple tree stem, we will observe, beginning at the

outside of the circle, first, the rough bark practically without life but nevertheless an important protection; next, a greenish ring of bark recently formed; next to this a thin green ring of wood. Several other greenish rings are usually present (sap-wood), then the color of the wood changes to a light or dark brown which we recognize under the name of heart-wood.

6.— *The deeply ridged bark of the locust.*

What is the difference between sap-wood and heart-wood? What do the annual rings mean? An apple tree in the process of growth produces, under normal conditions, each year two rings — one of new wood and the other of new bark. The ring of *wood* each year encloses — is laid *over* — that of the preceding season. The ring of *bark* is laid *under* last year's. This latter action results in pushing out and thickening the bark covering. As the stem expands, rifts and cracks are developed in the outer bark. Thus we have the shag-bark of the hickory, the ridges of the oak and pine and maple, and the scales of the apple and pear. Under these rough scales insects sometimes find comfortable winter quarters. That this rough bark protects the living parts within is shown by the lessened amount of sunscalding as the tree advances in years. It does not follow that all this rough scaly bark is necessary nor is it desirable that it should always remain.

The living part of the stem. Not all parts of the stem are alive. — Lesson 5, page 6, described the manner which the raw materials from the soil and those from the air unite and are gradually transformed into food and fibre for the sustenance and mechanical support of the tree. This elaborated food forms the new circle, called cambium at first, and by the inward passage and deposition of food thickens the cell walls in the older wood. In this way thin-walled sap-wood cells are changed to the dense and dead tissue making up the heart-wood. Which wood is most durable, sap-wood or heart-wood? If a piece of bark is scraped off the stem of an apple tree

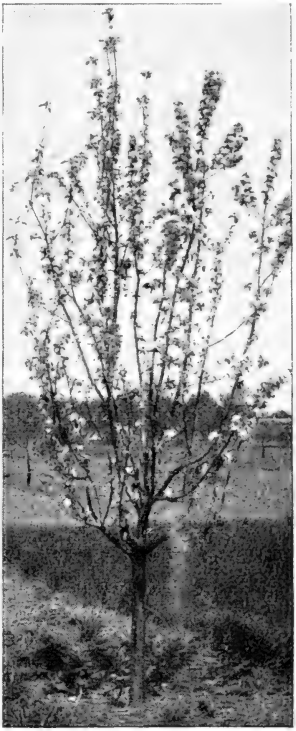
by cultivator or wagon hub, it is interesting to observe how nature attempts to repair the injury. It is about the ragged edges of the wound that new tissues are developed. The wood in the center is not immediately covered — in fact, may never be completely enclosed — but the area is decreased each year by deposits of new wood about the edges. This shows us that the life activities of the tree are located mainly between the bark and the new wood. This

7.—The crown and bole of a great Burr Oak near Cornell campus. How old?

is the vital part. A healthy condition of bark may be promoted by certain treatments. This and other matters of like nature will be discussed in a succeeding lesson. Have you ever seen a "hide-bound" tree? Top-graft a cherry on a plum stock and watch the result.

The crown.— This is composed of branches — which comprise the frame-work — twigs, or the small tributaries, and leaves, or the

stomach and lungs of the plant. Each variety of fruit has its characteristic habit of growth so that it is impracticable to endeavor to shape all alike. The spreading habit of the Greening distinguishes it from the upright Spy. It is important to so train the top that its branches will be properly distributed. A tree whose main branches diverge at or near the same point is likely to split under stress of wind and load of fruit. These faults are to be corrected by pruning in the nursery. This is the business of the grower. The twigs are of relatively less importance; some of them become leading branches, others die through lack of food and others support fruit spurs. As a rule it is not a good plan to trim the branches to bare poles. Have you ever seen a peach tree in this condition? The principles of pruning will be discussed in a later lesson.



8.—*An apple tree in blossom fed on the starch stored in its fruit buds.*

The leaves. Healthy leaves are essential to vigorous growth.— Lesson 5 described the all-important operation of manufacturing starch through the combined agency of the sun's rays, the green coloring matter of the leaf (chlorophyll) and the living matter (protoplasm) of the cell. Without starch production, tree growth is not possible. Unless the leaves are healthy, the formation of starch is partial and incomplete. The leaves are also the seat of the manufacture of the nitrogenous compounds used in building up the plant. A leaf riddled by shot-hole fungus or eaten by canker worm may be expected to do only half duty in the way of manufacturing starch. The fruit grower should then bring his energy and intelligence to bear on the problem of securing healthy leaves; he should be able to recognize enemies and know how to fight them. He should know that the tree produces two kinds of

buds — the fruit-bud and the leaf-bud. While the apples are growing this year the tree is making fruit-buds for next year's crop.

Careful microscopic observation has shown that the development of the fruit-bud begins a short time before the formation of the terminal bud. The terminal bud marks the close of the season's growth. The storing of the wood and fruit-buds with food follows, after the annual extension of wood has taken place. Should the leaf factories stop working as soon as wood growth is finished the logical result is that the fruit and wood-buds will not receive their share of prepared food.

Let us then watch closely the relation between healthy leaves and the development of fruit-buds. It sometimes happens that a canker worm raid in June takes half the leaves from an apple orchard. What effect will this have on the crop of the following year? The importance of healthy leaves cannot be overestimated They mean wood growth and fruit production. Without these the orchard is an unprofitable investment. Good leaves are secured by good tillage, intelligent pruning and careful spraying. These things will be discussed in future lessons.

The lesson of the tree.— First, the tree is a thing of life; it is composed of cells, active and inactive, of living and "dead" parts, of roots, stems and branches, all of which form a coöperative organism. Second, the tree grows vigorously and produces abundantly, in proportion to the ease with which it is able to secure food from the soil and air. There is a partnership between the roots and the leaves. The soil food may be ever so abundant and available, but if blight or bugs destroy the leaves, it cannot be made use of by the plant.

9.— *An elm planted by grandfather is now part of the home.*

UNIVERSITY EXTENSION IN AGRICULTURE.

CORNELL UNIVERSITY,
College of Agriculture.
NOVEMBER, 1900.

General Statement.

The Farmers' Reading-Course of the College of Agriculture of Cornell University was organized four years ago. Our reading circle of fifteen thousand farmers has been built up in that time. We believe that the suggestive Lessons issued have been appreciated and have done good work. We are led to this conclusion by the testimony of the readers of the Lessons. We wish to retain all our old readers and to add many new ones in order to make this Reading-Course of still greater use to the farmer. This is legitimate university extension. Farmers may not find it possible to come to the University themselves, but they can co-operate by sending their sons to the University, by helping in the formation of reading-clubs and by bringing their farming difficulties to the members of the staff of the College of Agriculture. If we cannot help you immediately, we will ask your assistance in carrying on experiments designed to solve your problems. The College of Agriculture will then attempt to aid the farmer with direct advice and suggestive hints gathered from its own experience and by direct experimentation on the farmer's fields. Through this latter means the farmer and the experimentalist are brought into close touch to their mutual benefit.

Ground Covered Thus Far.

The Reading-Course thus far has dealt with three fundamental things: The soil, the plant, the animal. A proper understanding of the method of soil formation suggests the way in which its fertility is best maintained; a knowledge of the way in which a plant obtains its food from the soil and the air and elaborates it in the leaves, emphasizes the desirability of preserving the latter from insect and funguous attack, so that it may perform its life functions in a proper manner; a knowledge of the principles of animal nutri-

tion is essential to the successful and profitable production of beef, milk and butter. These features have been set forth in Reading-Lessons 1 to 10. It is now proposed to specialize somewhat. This is what the college man does in his life work. After building a broad foundation by taking a general scientific course, he applies himself to a single problem at a time. In this way the problem receives his individual attention and he gets so much the more out of it.

Lessons for this Winter.

This winter we propose to take up questions relating to orcharding. We shall devote our first lesson to a consideration of the tree and its manner of growth, and succeeding lessons to the soil, its preparation, the planting and subsequent care of the tree and its fruit. The fruit interests of the State are of high importance. The fruit industry is exceedingly diversified. We have our apple districts, our peach sections, our grape belts, our strawberry and small fruit regions. The amount of capital invested is large. Success usually rewards the cultivator in proportion as the underlying principles of science and good business ability are combined and applied with industrious perseverance. It will be our endeavor in the lessons issued this winter to direct attention to some of these elementary but essential truths. Will it not be to your interest to send for sample copies of these Lessons? Let us hope that you will not only do this, but that you will organize a club.

How to Organize a Reading-Club.

The formation of a Reading-Club is a very simple matter. Let some one write us for information regarding this Reading-Course and the methods employed in carrying it on. We will gladly send him the desired information and a supply of Lessons. Then let this leader call a meeting at the Grange Hall or the school house or at his home. State the objects of the meeting. Distribute and examine the Lessons. Discuss matters informally and then take the names and addresses of all those who wish to become members of the Reading-Course, and forward them to us promptly. When the Lessons are received from us arrange to meet regularly once a fort-

night throughout the winter. Meet oftener if you wish, but intervals of more than two weeks between meetings are usually undesirable. Not less than two meetings should be devoted to each lesson. Thresh out the whole subject thoroughly. Do not run it over superficially. Conscientious criticism and courteous disagreement are much better than carelessness and indifference. Remember that our main object is to help the farmer to a better understanding of the underlying principles of his calling. There are no fees and no dues. The expense of this work is provided for by State appropriation under the provisions of the Agricultural Extension (Nixon) bill.

The Farmers' Reading-Course enterprise divides itself into three parts:

1. *Reading.* Organization of clubs. Lectures before these clubs by members of the Cornell College of Agriculture. Mutual correspondence and help. There are now three series of reading, either one or all of which may be taken up by the club:

A. The soil and fertility; plant growth.

B. Dairying and stock feeding.

C. Fruit growing.

2. *Experimenting.* When a Club finds that there is some serious agricultural difficulty in its region, arrangements may be made for field experiments on the subject during the summer season. Special attention is now called to a circular on coöperative experiments being carried on with field crops and commercial fertilizers.

3. *Winter-Course teaching.* Beginning early in January, a winter-course of 11 weeks will be given by the University Extension Staff of the College of Agriculture. This course is designed to meet the needs of the busy farmer's son. A circular giving explicit information regarding this course may be had on application.

Nov. 6, 1900. JOHN CRAIG,

Professor of University Extension
and Supervisor of Farmers' Reading-Course.

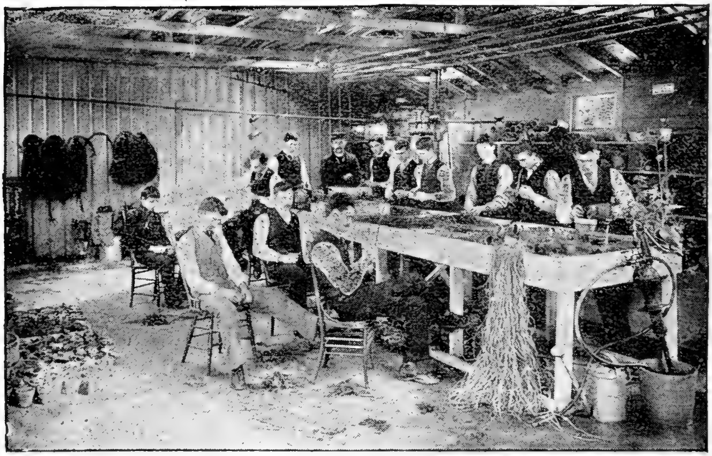
UNIVERSITY EXTENSION DEPARTMENT.

Comprises:

WINTER COURSE IN AGRICULTURE.
FARMERS' READING-COURSE.
BUREAU OF NATURE STUDY.

PUBLICATIONS OF THIS DEPARTMENT:

FARMERS' READING-COURSE LESSONS.
NATURE-STUDY QUARTERLY.
JUNIOR NATURALIST'S MONTHLY.



Laboratory work in Horticulture. How fruit trees are made by root-grafting.

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UNIVERSITY EXTENSION.

A WINTER COURSE IN AGRICULTURE.

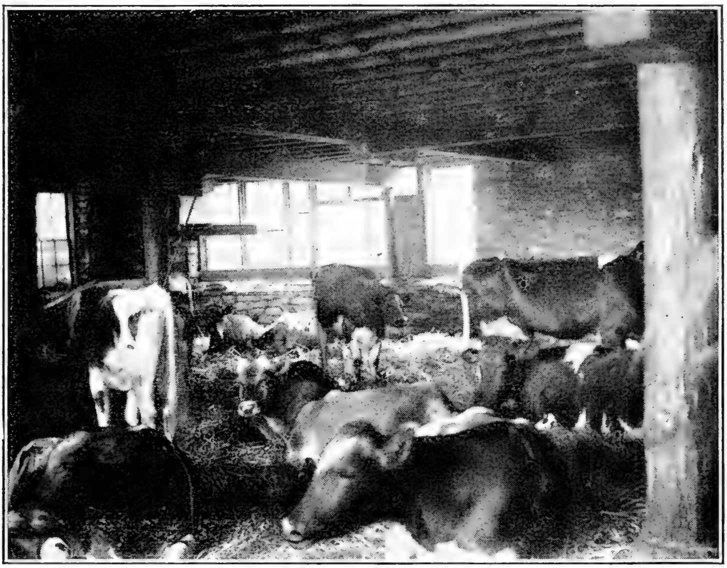
CORNELL UNIVERSITY,

College of Agriculture.

NOVEMBER, 1900.

Designed to Meet the Needs of Busy Farmers' Sons.

The College of Agriculture of Cornell University endeavors to improve the position of the New York farmer in three ways:



1. Through the regular means of instruction given in the special course of two years, the regular course of four years and the post graduate courses. These lines of study are designed to meet the desires of those who have time, inclination and money to complete them.

2. By means of a winter-course in agriculture and allied branches, arranged to meet the needs of farmers, gardeners and their sons who are unable to spare the time necessary to complete the longer courses, but who are desirous of equipping themselves with a knowledge of the fundamental principles underlying their chosen calling in life.

3. By means of the Farmers' Reading-Course, which has been organized to assist the farmers to a better understanding of the truths which are the foundation stones of a successful agriculture.

The University courses (1) are fully outlined in the annual catalogue, a copy of which may be had on application to the Director of the College of Agriculture, Cornell University, Ithaca, N. Y. The Farmers' Reading-Course (3) is fully described in a circular which will be gladly sent to all who are interested. In this circular we call special attention to the winter-course in agriculture, the advantages of which we wish to set clearly before the young farmers of the State. This course is free to every farmer in the State.

Scope of the Work.

The winter-course is an epitome of the regular university course in agriculture. It is a fitting conclusion of the Farmers' Reading-Course. It aims to crystallize into practical outline the principles and theories set forth in the Lessons. It aims also to strengthen the desire for experiment on the part of the farmer, because personal investigation of local conditions is essential to the fullest success.

It is expected that every student taking this course comes with a firm resolve to make the best possible use of his time and with more or less definite views regarding his future. Such men get most out of the advantages offered. In the short time given to this course, it is impossible to treat the subjects with that fullness which characterizes the instruction given in the regular courses. The aim is to emphasize the fundamental principles of farm practice. The instruction naturally groups itself about the three heads into which farm work may be subdivided: 1. The soil. 2. The plant. 3. The animal. The time of the student will be about equally divided between these three groups. After dealing with principles, as much time as possible will be given to the consideration of details, such as rotation of crops, the care of fruit trees and the feeding of animals.

Courses of Study.

Agriculture. A study of field crops and farm management, devoting as much time as possible to the details of special crops, as

corn, potatoes, wheat and oats. Course in charge of Prof. ROBERTS and Mr. G. L. STONE.

ANIMAL INDUSTRY. Principles of breeding animals, history and development of dairy and beef breeds of cattle, and other domestic animals. Assist. Prof. WING and Mr. G. L. STONE.

DAIRY HUSBANDRY. Instruction in butter and cheese making and the feeding of dairy animals. Assist. Prof. WING and Mr. J. A. FOORD.

HORTICULTURE. An examination of the principles of fruit culture with laboratory practice in the propagation of plants. Prof. CRAIG.

CHEMISTRY OF THE FARM. A study of soil formation, the composition of plants, and the maintenance of fertility by commercial fertilizers and farm yard manures. Prof. G. C. CALDWELL and Mr. G. W. CAVANAUGH.

ECONOMIC ENTOMOLOGY. A discussion of the more important insect pests and the special methods of combating them. Assist. Prof. SLINGERLAND.

APPLIED BOTANY. A study of the fundamental principles of how the plant grows; food supply and the influence of external conditions with special reference to cultivated plants. Assist. Prof. DUGGAR.

POULTRY KEEPING. A discussion of the domestic breeds of poultry, principles of feeding and management. Assist. Prof. WING.

DISEASES OF FARM ANIMALS. This is a special course of lectures arranged and given for the benefit of winter-course students by Prof. LAW.

THE FARM LIBRARY. This course has to do with the selection of a small home library including books of popular science, history and literature. These will be examined and discussed. Course given by Mrs. ANNA BOTSFORD COMSTOCK.

The greater part of the work outlined above is required; that is, it must be taken by each student, but the student has the option of selecting from the remainder certain studies called electives which he may take if qualified and disposed.

Special Lectures and Seminaries.—In addition to the above, winter-course students will have the privilege of hearing special lectures by the heads of the departments of the College of Agricul-

ture and prominent educators in somewhat closely allied fields. The agricultural and horticultural clubs are open to winter-course students, who are cordially invited to come and take part in the discussions. A seminary is organized and conducted each winter by the students of this course, thereby adding much to the interest and enjoyment of the work.

Expenses.— The expenses of the winter course are practically the living expenses of residence in Ithaca, in addition to a fee of $5.00 for general winter-course students, and a fee of $8.50 for general winter-course students electing practice in dairy husbandry. The cost of board and lodging in Ithaca varies from $3.50 to $5.00 per week.

JOHN CRAIG,

Professor of University Extension.

CORNELL UNIVERSITY,
COLLEGE OF AGRICULTURE,
ITHACA, *Nov.* 10, 1900.

Easter Strawberries Grown at C. U. Forcing House.

CORNELL READING-COURSE FOR FARMERS.

QUIZ ON READING-LESSON NO. 11.

NOVEMBER. 1900.

BY JOHN CRAIG.

These questions constitute a supplement to Reading Lesson No. 11 (A Tree). Its purpose is to induce the reader to think carefully about what he reads. Answer the questions as best you can and return this sheet to us (2 cents postage). We want these answers in order that we may know what interest you are taking in the Reading-Course and how much good you are getting from it; and we want to help you when you do not understand the problems involved We are after results, and do not care about the handwriting nor the grammar. These answers are for our own examination and are not to be made public. We should be glad of any comments on these lessons.

It is hoped that readers will form themselves into little clubs, to meet once or twice a month to discuss the problems raised by the lessons.

Those who answer the questions will receive future lessons.

1. In planting a tree what part should be treated with most care?

2. Have you ever dug a small tree with sufficient care to save most of its roots? What was the extent of the root system?

3. Have you noticed any difference in the character of roots of different kinds of apples? Give specific instances, if possible.

4 Which influences the form of the roots most, the fertility of the soil or its physical condition? Why?

5. Why do fruit trees often stand still, making no sign of growth for a long time after they have been planted?

6. How long do root-hairs persist? Do they die every year, every second year, or do they last indefinitely? Prove your answer.

7. Why are forest trees commonly shallow rooted?

8. What influence might constant mulching have on the roots of fruit trees?

9. Why do fruit trees injured by borer or whiffletree often bear fruit earlier than sound trees?

10. How does ringing affect the part above the ring?

11. How does an injury to the stem of a tree affect the food supply of the crown?

12. Does the trunk of a tree grow longer or shorter after the head forms?

13. How does an injury to the leaves affect the food supply?

14. Of what benefit is the heartwood to a mature apple tree?

15. How has the discussion given you clearer views regarding the principles of tree growth and culture?

16. Have you had any experience in orcharding?

17. What have been your difficulties?

18. Do any of these troubles suggest useful lines of experiment?

Name.................................

Address. ....

CORNELL READING-COURSE FOR FARMERS.

Issued by the College of Agriculture, Cornell University, Ithaca, N. Y., in the months of November, December, January, February and March.

Entered at the Post office at Ithaca, N. Y., as second class matter under act of July, 1894.

READING-LESSON NO. 12.

DECEMBER, 1900.

BY JOHN CRAIG.

Orcharding.

A SURVEY OF THE PRELIMINARIES.

Classes of fruit growers.— There are two kinds of orchardists. The person who grows fruit primarily for family use and because the work is interesting is termed an amateur. On the other hand, the person who makes orcharding a main or strong feature of his farming operations is called a commercial grower. Every one who has land may be an amateur fruit grower; but favorable soil and climatic conditions, coupled with industry, intelligence and perseverance, are needed to make the successful commercialist.

The site. It is possible to grow good apples for a few years on almost any kind of soil; but if we would grow long-lived trees and fruit of superior quality, then the climate, site and soil must all be favorable.— The site is the place in which we intend to plant the orchard. We may have two or three sites equally desirable and differing only in the direction of their slope. The slope is what orchardists term the aspect, as, for instance, a southern aspect, a northern aspect, eastern or western. This matter of aspect is important. The south and west slopes are hottest in summer and present better opportunity for sudden climatic changes than northern or eastern slopes. Does this agree with the plant as well as more equable conditions? On south slopes, peach trees, for instance, are brought into flower earlier than on north and east slopes, consequently are more liable to frost injury. In a succeeding lesson we shall talk about the reasons of frost injury to trees dormant and

trees in a state of vegetative activity. In the western plains country the most luxuriant growth of native timbers is always found on the north slopes. This peculiarity is less marked in New York because the climatic changes are less severe and less sudden, and the sun's rays are less intense. Extreme heat in summer injures trees as well as extreme cold, often deadening the bark and scorching the fruit. This fortunately is less frequent in New York than in the west. In spring the injury known as sun-scalding is caused by hot weather followed by sharp frost. South slopes favor difficulties of this nature. To sum up, the north or east slopes are usually most favorable to fruit tree culture because climatic variations are less extreme than on the south or west slopes. Elevated areas are to be preferred to low-lying ground because cold air is heavier than warm air and settles to the lowest levels. Bottom lands catch frost earlier than upland slopes. Look up the subject of air-drainage.

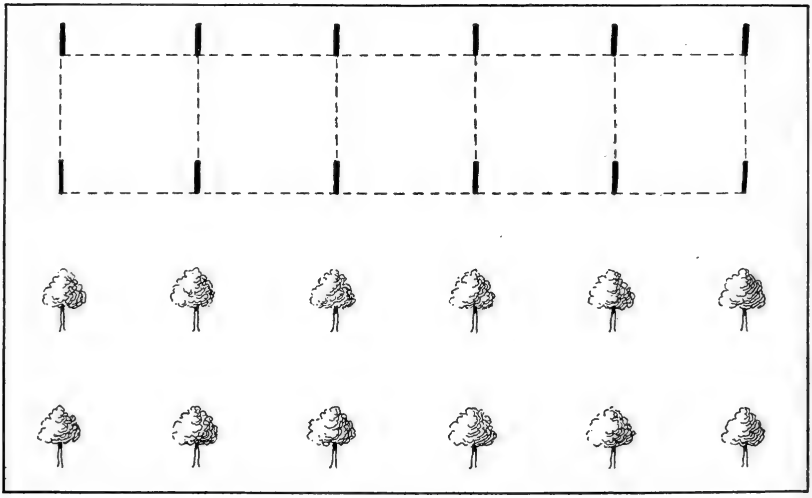
The soil is an important factor in fruit growing.— A correspondent writes: "I have a piece of sandy ground. I would like to raise an apple orchard. Can I do it on this soil?" "Yes, certainly," we answer. "You can at least grow enough for your own use, but we would not advise you to plant extensively of apples on such soil, because it is better adapted to other crops, peaches for instance, if the climate admits, or for garden truck." Another correspondent asks if we "would plant peaches on heavy clay." Our answer would be: "Yes, rather than forego the pleasure of trying to grow peaches." While the ideal soil for an apple and plum orchard is probably a friable clay loam, and that for the peach tree a light sandy loam, we should not give up these fruits, because they add to personal interests and may be grown for home use, though the ideal soil is wanting.

Preparation of the soil as important as the kind of soil.— In Lesson No. 1 the various methods of improving the texture of the soil were discussed. It is bad economy to plant trees on hard, "sour," or poor land. See Lesson 11. But poor land may be enriched. The land should be as thoroughly prepared as if it were intended for a corn crop. The roots of trees forage widely and

deeply. If the ground is hard, wet or poor, root growth is restricted and as a matter of course top growth is also. Underdraining is of prime importance. In nine cases out of ten it will pay, whether the land is springy or not. (For the benefits of underdrainage, review Lesson 2.) Tillage and underdrainage are therefore of prime importance in preparing desirable foraging ground for the roots of the trees. No amount of subsequent labor can fully make up for badly prepared orchard ground. The more thoroughly pulverized, drained and deepened the soil is, the farther will the roots travel for plant-food and the more will they obtain. There are other reasons for softening the subsoil and lowering the water level: The roots of trees penetrate deeper and the fruit is injured less in time of drought. (The past season was very dry at Ithaca; apple trees in sod yielded small apples, which dropped early.) It will be seen from the above that the term "thorough preparation of the soil" means as much when applied to the tree grown as a farm crop as when applied to staples like wheat or corn. The soil must be drained, deepened and pulverized — in short, subdued. The subsoil plow may be used. It has important work to do in preparing orchard ground. While doing this other crops may be grown on it. Crops which require cultivation for at least part of the season are best. Why? Consult Lesson 2, paragraph 3. You are preparing plant-food for the orchard tree. How the plant gets its food from the soil was discussed in Lesson 4.

Time to plant.— One of the perennial inquiries addressed to the experiment station man runs like this: "I am thinking of planting an orchard. When should I set the trees, in the fall or spring?" The question is not an easy one to answer. Conditions of climate and soil are the governing factors. Most people will admit that fall, so far as convenience is concerned, is the best time to plant. Then why not plant in the fall? Let us look into the matter. Suppose that we cut three branches from the same tree in the fall. One of these we will bury in the ground, the second we will plant like a tree, and the third we will lay on top of the ground. What will be the condition of these three branches in the spring? You will say "that would depend upon the kind of winter." If a winter

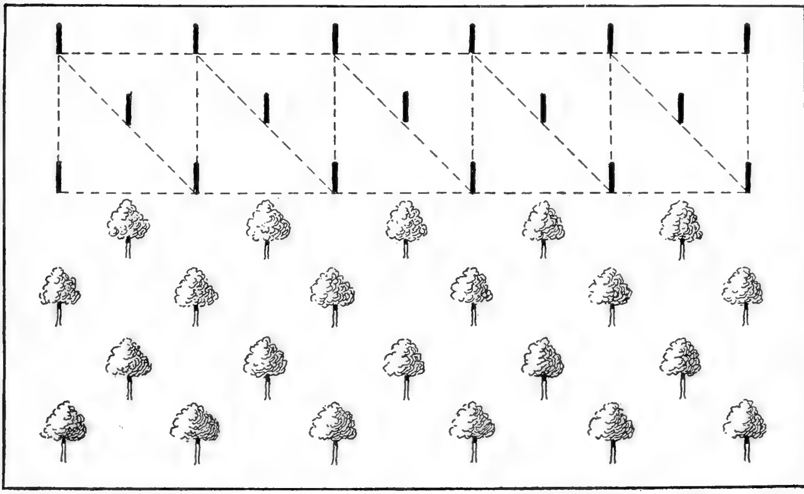
with light snow and rainfall followed, the twig on the surface would be shriveled (dried out) and worthless; that stuck in the soil would probably be shriveled at the tip and green toward the base; while the one which was buried in the ground would be plump and green throughout. The branch had been separated from the parent stem which supplied it with moisture. When placed in a dry atmosphere it lost its sap by evaporation. When this dryness passes a certain point the contents of the plant's cells shrivel and the thing we call life is lost. Now, there are parts of the country in which branches of trees stuck in the ground will lose very little by evaporation.



10.— *Planting in squares.*

These localities are the coast climates of the south and east where the atmosphere is moist. An apple tree when dug in the fall is not strictly comparable to the branch because it is supplied with water-absorbing organs (see Lesson 4, paragraphs 1–4). Nevertheless, there is a likeness. The tree is dormant and the root-hairs are not formed in cold weather. Absorption is sluggish or quiescent, and during periods of dry, windy, freezing weather in winter the tips may shrivel and die. This is what often follows late fall planting. Because of this possibility, should we avoid fall planting? Can we not overcome this difficulty by planting early enough to allow the

roots to become established — in other words, early enough to allow root growth to begin before cold weather arrives? We think this is possible. Most trees ripen their wood in Central New York, as a rule, by the first or middle of September. If transplanted about the middle of September root growth ought to commence before severe frost. Is not this reasonable? The difficulties with spring planting are briefly these: Trees may be injured in the storage house or "heeled in" in the ground over winter; they may arrive late in the spring, and they always come when the farmer's hands are more than full with other kinds of work. The planting is likely to be



11.—*Planting in quincunx.*

hastily done. If the ground is moist and weather favorable the trees may leaf out promptly, because starch for next year's buds is stored during early summer and fall (see Lesson 5); but unless the roots actively respond, growth will not continue after the stored starch is consumed. Of course healthy trees planted in early spring ought to succeed. In fact, the usual counsel given is to plant in spring. Weigh the matter in your own mind, and if you feel like it, try a small experiment for your personal satisfaction.

How to lay out the fruit plantation.—The rows should be straight for convenience in cultivating as well as for appearance's sake.

There are two general plans of planting: in squares and in quincunx. The latter plan places five plants in each square. That is, in addition to the trees forming the corners of the square, one is set in the center of each square.

How the plantation shall be laid out is a matter which in a measure must be governed by conditions. The usual method finds first a reliable base line; then the boundary stakes are set at right angles. These stakes mark the rows, but should be outside of the first row of trees so that they will not be interfered with in digging the holes, and will be available for lining-in the trees. Lines or planting boards may be used. On small level areas a corn marker is serviceable. For full directions regarding methods, see Principles of Fruit-Growing, Bailey.

Planting.— How far apart shall we set trees? This is largely a personal question depending on the aims and ideals of the orchardist. With double-planting or mixed planting — that is, when different classes of fruits, as cherries, peaches and apples, are mixed in the same orchard,— the ground can be very thoroughly utilized from the outset. The early bearing kinds are expected to pay for the cost of cultivation and rent of land while the slow bearers are preparing to begin work.

The following maximum distances are generally recommended for the leading classes of fruits. (See "Principles of Fruit-Growing," page 240.)

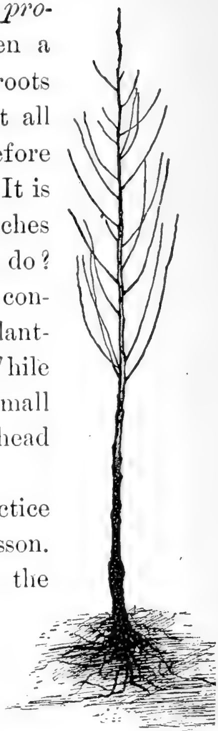
Apples, 40 feet each way.
Apples, dwarf, 10 to 15 feet.
Pears, standard, 20 to 25 feet.
Pears, dwarf, 12 feet to 1 rod.
Quinces, 1 rod.
Peaches and nectarines, 20 feet.
Raspberries, 3 x 6 to 5 x 8 feet.
Strawberries, 1 x 3 or 4 feet.
Plums, 20 feet.
Apricots, 20 feet.
Cherries, sour, 20 feet.
Cherries, sweet, 30 feet.

Grapes, 6 x 8 to 8 x 10 feet.
Currants, 4 x 6 to 6 x 8 feet.
Blackberries, 4 x 7 to 6 x 9 feet.

Preserve the vitality of the tree if you would have it grow promptly.— In handling and setting trees how many of us bear in mind that the tree is a thing with life, and that under careless treatment the life will go out of the plant as it goes out of the animal? Trees are made up of a great number of little cells. Some of these may be killed and yet the injury may be repaired by the subsequent growth of the others, but let the injury pass a certain point and there is no resurrection. Trees may lie around the packing shed of the nurserymen; they may remain in the bundle in the express office some days before the farmer can come to town; they may not be unpacked promptly on his return from town; and worst of all, their roots may be carelessly exposed to wind and sun during the planting operations. Let us avoid injuring the tree in any of these ways.

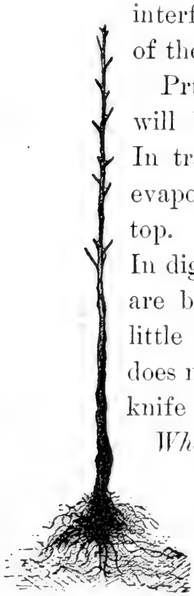
Plant the tree firmly so that it can get hold of plant-food quickly. — In seeding land during dry weather, why is it a good plan to roll the ground? Seeds will germinate quicker because brought more closely into contact with the soil moisture by this packing of the soil particles. In planting the tree, should not the soil be packed tightly against the roots? Why? To afford mechanical support, to steady the tree, and to encourage roots to absorb water from soil. Of course good sized holes should be dug, not merely big enough to receive the roots, but large enough to give them friable foraging ground when they begin to grow. Plant an inch or two deeper than the tree stood in nursery. Light soil calls for deeper planting than heavy soil. The careful planter will use his hand to make sure that the soil is tightly packed in the forks of the roots. The top soil is richest; fill it in first so it may be used. Should he leave the surface loose or firmly tramped down? The condition of the surface soil affects evaporation of soil moisture. (See Lesson 2.) The soil mulch is of less importance in the fall than it is in the spring when moisture is needed and drying winds are frequent — at any rate cultivation should immediately follow spring planting of orchard trees.

In digging the nursery tree the natural proportions of root and top are disturbed.—When a nursery-grown tree is dug a large share of its roots is left in the soil. The feeding roots are almost all left behind; but the top is undisturbed. It therefore goes into business in an unbalanced condition. It is top-heavy. There are too many buds and branches for its diminished root system. What should we do? Balance the tree by "heading-in." This is done conveniently after the tree is planted. In late fall planting, the heading-back may be left till spring. While this is being done it is a good time to remove small interfering branches and to shape the head of the tree generally.



12. — *One-year peach tree before pruning.*

Pruning as a part of orchard practice will be taken up in a succeeding lesson. In transplanting we prune to lessen the evaporating (transpiring) area of the top. The roots need attending to also. In digging and shipping the trees they are bruised and broken. Practice a little tree surgery. Bruised tissue does not heal readily. With a sharp knife cut off all these injured parts.



13.—*One-year peach tree pruned. Apple trees are transplanted at two years and are not pruned so severely.*

Where to buy and what to buy.— This is largely a business consideration. Buy from a reliable firm; buy as near home as possible; deal directly with the grower. When trees are purchased of salesmen or dealers the responsibility of the grower is diluted to that extent, and when difficulties arise the purchaser finds redress all the more difficult. Then, too, the trees are more likely to receive injury in a long haul than in a short haul. It is true also that as a general rule, home-grown trees are better adapted to the surroundings and may be planted in better condition than

those shipped in. It is just as important in growing an orchard to start with healthy trees as it is to begin with healthy parents in raising a herd of cattle. Trees may be infested with insects or they may be unhealthy because of bad treatment or bad weather. The sign of a healthy tree is clean bright bark and white wood. Many young trees are "black hearted," owing perhaps to winter injury in nursery. Such trees are not first class; they should not be planted.

What to plant is a personal consideration. If one is going into the business, then study the market, and plant such varieties as experience has shown thrive well and sell well. A man may plant what he likes for his own use, and may also grow particularly high grade types if he wishes to cultivate a special trade.

Windbreaks for the orchard are sometimes necessary. The subject cannot be taken up at length here, but it should be studied by the person who intends to plant an orchard. The windbreak is at once an advantage and a detriment to an orchard. It lessens wind falls by protecting the fruit from wind storms, but it may encourage and harbor insects. It saves moisture by arresting drying winds, but it may rob the orchard trees of food and soil moisture. Do the benefits conferred outweigh the incident injuries? We think so. Do you? The subject of orchard windbreaks is discussed in "Principles of Fruit Growing," page 62.

In our next lesson we will take up orchard management.

14.—*A planting board may be used to find the place of the tree.*

CORNELL READING-COURSE FOR FARMERS.

QUIZ ON READING-LESSON NO. 12.

DECEMBER, 1900.

BY JOHN CRAIG.

These questions constitute a supplement to Reading Lesson No. 12 (Orcharding: the preliminaries). Its purpose is to induce the reader to think carefully about what he reads. Answer the questions as best you can and return this sheet to us (2 cents postage). We want these answers in order that we may know what interest you are taking in the Reading-Course and how much good you are getting from it; and we want to help you when you do not understand the problems involved. We are after results, and do not care about the handwriting nor the grammar. These answers are for our own examination and are not to be made public. We should be glad of any comments on these lessons.

It is hoped that readers will form themselves into little clubs, to meet once or twice a month to discuss the problems raised by the lessons.

Those who answer the questions will receive future lessons.

1. In planting an orchard why are slopes and elevated lands better sites than bottom lands?

2. Why does not the same principle govern the planting of grape vines, sweet potatoes and watermelons?

3. If you want early tomatoes what aspect would you choose? Why?

4. What determines the fitness of a given region for growing orchard fruits on a commercial scale?

5. When is it bad policy to attempt commercial orcharding?

6. What is the difference between the amateur and commercial fruit grower?

7. What do you consider the most favorable soil for apple growing?

8. How would you prepare a pasture field for fruit trees?

9. Why is deep plowing of great importance?

10. How would you prepare a hillside with good soil and favorable aspect but which was sour and springy in places?

11. What risks do we run in planting in the fall?

12. What are the objections to spring planting?

13. What do you understand by the following systems of planting: (a) squares; (b) quincunx; (c) mixed?

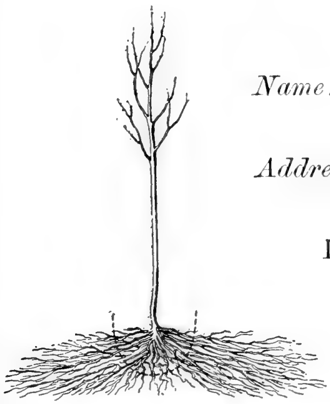
14. What advantage is there in planting peaches and apples in the same orchard?

15. What is the cause of much failure in the case of newly set orchard trees?

16. Why should a tree be cut back when it is transplanted?

17. How can you distinguish a healthy tree from an unthrifty one?

18. With what fruits have you been most successful?



15.—*The dotted line is to show the proportion of roots left in the ground when the tree is transplanted.*

Name....................................

Address............... ....

In forwarding answers detach quiz from Lesson.

CORNELL READING-COURSE FOR FARMERS.

Issued by the College of Agriculture, Cornell University, Ithaca, N. Y., in the months of November, December, January, February and March.

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READING-LESSON NO. 13.

JANUARY, 1901.

BY JOHN CRAIG.

Orcharding.

MANAGEMENT OF THE ORCHARD.

Tillage affects the soil in three ways: It improves its physical condition; it conserves moisture; it hastens and encourages chemical action.

In lesson 1, page 5, the soil's texture is discussed very fully. It is shown that although a soil may be rich because it contains an

16.—*Mixed planting. Burbank and Abundance plums. The interspaces occupied with currants.* (*A pleasant grouping of plums, currants and Junior Naturalists.*)

abundance of the elements of plant-food, at the same time it may be unproductive. The fertility of the land is its productive power;

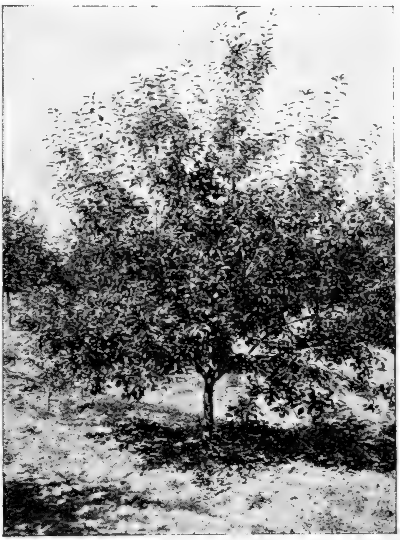
tillage is one of the means by which this productive power may be increased. Moisture is an important factor in fruit-growing. The importance of water to the apple and peach tree was very clearly shown by the experience of last summer. The rainfall throughout central New York was much below the normal amount for the months of July, August and September. What was the result in untilled orchards as compared with that in well tilled fruit lands? As a rule the apples in sod orchards were undersize; they lacked color and were often deficient in natural juiciness. This fruit presented a marked contrast to that grown in orchards that had been tilled carefully throughout the season.

The fruit-grower's program of cultivation.— Of what should this consist? In the spring his object is to get his soil laboratory in working condition as early as possible. To do this he plows the orchard land. The plowing of the ground does several things. It lowers the water-table; it increases the water reservoir; it allows the air to permeate; it encourages the nitrifying processes. While as a rule the plow should be the first implement introduced in the orchard in the spring, there are conditions which prohibit its use. Obviously it is not the ideal implement with which to carry on summer cultivation. In spring it not only releases and tends to remove soil water, but it adds to the soil's capacity for holding water. In later summer the energies of the fruit-grower should be directed to saving for the use of the tree as much moisture as well drained land will naturally hold. The disc harrow is probably the most effective implement to follow the plow. This pulverizes the clods and tough lumps of soil and leaves the land in good condition for the smoothing harrow which should follow the disc.

The primary objects of tillage are to save moisture and release plant-food rather than to kill weeds. A farmer may ask, "Should I use the cultivator just often enough to keep down weeds or ought I to cultivate at least once a week?" Weed growth may not be looked upon as a reliable guide to the orchardist in the matter of cultivating. The character of the soil and the amount of rainfall together form a much safer standard to guide our practice. If a heavy rain storm should follow within twenty-four hours of culti-

vating the orchard, it might be necessary to repeat the work within the next forty-eight hours. The surface mulch must be maintained.

There is a distinct difference between the status of an orchard when viewed as a farm crop, and a field of wheat or corn.—The apple tree is planted in a certain place; it is fixed and immovable and is dependent for sustenance on the food within reach of its roots. The situation may remain unchanged year after year. The tree may continue to starve or to revel in high living. The drain on the soil's storehouse of food increases year after year and is emphatically augmented when bearing age is reached. These conditions make the tree at once a hard boarder and a helpless boarder. The wheat plant has only a year of existence. If the conditions are favorable it produces flowers and seed, and the stem with the grain is gathered; but the root is left in the ground to compensate in a measure for the plant-food used in perfecting the kernel. Farmers manure wheat ground every year. Should not fruit trees receive treatment equally generous? Do not the trees make an annual draft on the plant-food of the soil?



17.—*An orchard tree six years planted. Tilled, pruned and sprayed.*

Fruit trees are in themselves a sufficient crop for the ground on which they stand.—This is especially true after the tree comes into bearing. We may deviate somewhat from the rule in the case of apple trees which are planted thirty-five or forty feet apart. In cases of this kind other crops may be grown in the interspaces. What type of crop to grow is an important question. Shall we grow something cultivable, or a cereal, such as wheat or oats, that occupies the entire surface of the ground? It may be said that the soil moisture is saved somewhat in proportion to the area of surface

cultivated. In the case of the wheat crop, not only does the plant compete with the tree for moisture and available plant-food, but it allows of greater evaporation from the soil than occurs in the case of a plant grown in rows,—like the turnip, sugar beet or potato. Then, too, the wheat plant requires its moisture in the early part of the season; so does the apple. At this time the tree is making wood and the wheat plant is making kernel. We should avoid, as far as possible, this injurious competition.

Orchards require clean cultivation during the tree's growing season, but the soil also needs humus to preserve a good physical condition and to promote chemical activity.— See Lesson 1. In Lesson 2 the necessity of maintaining the supply of humus was

18.—*A three-year-old peach orchard showing the effect of good care.*

made clear. This thought has particular force for the fruit-grower. When an orchard is constantly under clean tillage the store of humus gradually diminishes. The truth of this statement finds ready corroboration in the story of worn out nursery lands, where the drain upon humus has been excessive. With the nurseryman, cultivation is essential to the production of salable trees. The whole strength of the soil is reserved for the tree. No weed growth is allowed to compete with the tree during its period of growth, and the ground is often kept clean throughout the entire season as a safeguard against mice and rabbits. When the tree is dug it is removed literally root and branch. This is worse than the case

against the wheat or corn plant, where the roots are left in the soil and add to the store of humus. In order to preserve the balance, the nurseryman is obliged to do one of two things — he must practice a rotation which will keep up this supply, or he is obliged to constantly seek new land. It is due to this fact that large quantities of fruit stocks and nursery trees are grown in the new lands of the western plains country.

A cover-crop is a crop sown in the orchard at the close of the tillage season, to produce a supply of humus, to promote nitrification, to prevent the leaching and eroding effects of fall and spring rains, and to protect the roots of the trees from excessive cold.—The cover-crop is one of the most important factors in successful orcharding at the present time. Orchard cultivation has been urged for a number of years; it has been practiced in many localities and the results obtained have encouraged orchardists to continue the practice; but clean cultivation has its limitations and must not be carried too far. It should apply only to the growing season of the tree. The ground at that time should be in a perfect condition of tilth. The dust blanket should be so thoroughly maintained that the film moisture of the soil is completely preserved. In this condition the soil furnishes a favorable seed-bed, and even small seeds may be expected to germinate successfully.

The cover-crop is sown in mid-summer and is expected to produce a mat of surface vegetation that will cover the ground thickly before autumn comes. One of the difficulties in growing cover-crops is to obtain a good "catch." If the orchard has not been thoroughly cultivated a good catch is hard to secure. On the other hand, if tillage has been thorough there is usually no trouble in obtaining a good stand. As a rule the smaller the seed, the more uncertain the catch. Why? Small seeds should not be covered deeply. They are therefore more at the mercy of external conditions than are large seeds, which in themselves have a considerable store of nourishment and for that reason may be planted deeper. Clover is often sown on the surface, while peas and beans should always be drilled in. Rolling the ground during dry weather, after sowing the seed, is very important. In planting the nursery tree

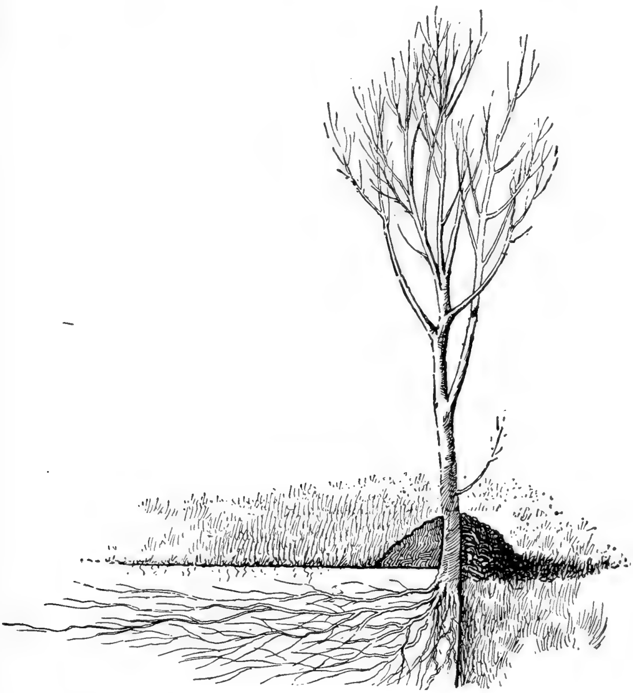
we have said that the earth should be packed firmly against the roots so that they can readily absorb moisture. So it is with the seed awaiting germination; it germinates promptly when it is able to absorb soil moisture and is under the influence of a sufficient degree of warmth. For this reason clover seed rolled in, will germinate quicker on dryish soil than unrolled seed. The character of the soil must be taken into consideration in connection with the treatment it should receive.

Cover-crop plants are of two types: leguminous and non-leguminous. The leguminous are usually the more valuable.— Among desirable leguminous plants for the orchard are the clovers, peas, beans and vetches. Among the non-leguminous types are buckwheat, rye and rape. The legumes are nitrogen collectors. For this reason they are much more valuable than the non-leguminous class. As a rule, too, roots of clover penetrate very deeply. In this respect they are of particular value in improving the physical qualities of the soil.

To obtain the full benefit of the cover-crop it should be plowed under early in the spring. There is a temptation to give the cover-crop a chance to make growth in spring before plowing it under. This is bad practice except when the land has too much moisture; in these circumstances it may be of some service in using surplus water. If it is allowed to grow strong and rank before turning under, the fibre becomes tough and does not readily decay. On the other hand, if turned under early in spring, as soon as the ground can be worked, decay sets in promptly, and the humus thus produced becomes a prompt worker in carrying out its mission in the soil. Think of the mission of green manure.

Manurés for orchard crops are mainly of two kinds: those from domestic sources and those produced by the manufacturer. The latter are commonly called "commercial fertilizers."— Barnyard manure influences the soil in two ways: (1) By means of the plant-food furnished; and (2) by the addition of vegetable fibre, which improves the physical condition. If the land is sticky clay it is made more porous and less compact. The insoluble particles are separated and are thus more readily acted upon by dissolving

and nitrifying agents. Sandy land is improved also by having the interspaces filled with vegetable matter, which greatly increases its absorptive capacity. A leading difference between the commercial fertilizer and the barnyard manure lies in this secondary function possessed by the latter, viz.: that of improving the physical character of the soil. (See Voorhees on Fertilizers.) The commercial fertilizer cannot be counted on to improve greatly the physical character



19.— *Place the manure where the feeding roots can use it, not in a pile at the base of the tree only.*

of the soil; its chief function is to furnish plant-food. The indirect or secondary effects of commercial fertilizers are slight. The commercial fertilizer adds to the soil the essential food constituents, while the barnyard manure does this and in addition helps to make the constituents, already in the soil, serve as food to the plant. These considerations show at once the value of barnyard manure

for hard and dry soils. It is a general fertilizer; it furnishes a certain amount of the three principal elements of plant-food: nitrogen, phosphoric acid and potash. Commercial fertilizers are often special manures. The term "phosphates," which applies only to fertilizers whose chief constituent of fertility is phosphoric acid, is often erroneously taken by farmers to mean a complete manure.

The supply of barnyard manure is limited; it cannot always be obtained. What shall we substitute? — The orchardist may not be able to secure barnyard manure but he can always make use of "green manures." By this term "is meant a crop which is primarily grown for the purpose of improving the soil and not for the harvested product." (Voorhees, Fertilizers, p. 118.)

These green manures are of two classes: nitrogen collectors and nitrogen consumers.— The members of the first class are able to gather nitrogen from the air in addition to that which they take from the soil. Those of the second class can only obtain it from the soil. When we grow the nitrogen collector and plow it under, we save the nitrogen taken from the air as well as that from the soil. When we grow the nitrogen-consumer and plow it under, we have only given back to the soil in a slightly changed form the nitrogen originally taken from it.

Commercial fertilizers are of two classes, standard high-grade fertilizers and those which are variable in composition and availability, called low-grade. (Review Lesson 3.) — Among commercial fertilizers there are certain materials whose composition and availability are fairly constant. Nitrate of soda, sulphate of ammonia and dried blood are called high-grade standards, because their composition may be depended upon to vary but little. These are nitrogenous fertilizers, and the nitrogen is usually in a form of ammonia which is immediately available.

In the phosphates the phosphoric acid is not directly available. Because of this fact the standard supplies of phosphoric acid are derived from these materials after they are manufactured into superphosphates. There are many kinds of these superphosphates. They may be considered standards, as they always contain a high percentage of available phosphoric acid. South Carolina and Ten-

nessee rock phosphates are the standard basic materials from which superphosphates are manufactured.

There are also high-grade potash fertilizers. Among these are the German potash salts, which may be depended upon to give a fairly constant percentage of potash. The above and other nitrogenous, phosphatic and potassic compounds are worked over by the manufacturer of commercial fertilizers, and form what we commonly know as commercial fertilizers.

The different food elements should not be expected to perform certain specific things in the building up of the plant.— The question is often asked, "Can I, by the use of certain fertilizers, accomplish certain definite results?" It is unwise to give any such assurrance. It may be safe to generalize somewhat as follows:

Nitrogen.— If nitrogen is used in excess it is more than probable that a luxuriant growth will result. If the orchard, therefore, is making plenty of wood, and is carrying healthy foliage, this would suggest that nitrogen, as a special fertilizer, was not needed. If, on the other hand, the growth is meagre and stunted, an application of some material containing nitrogen in excess might be expected to give good results. The effect of fertilizers is not always seen on trees the first or even the second year of their application. The results may follow two or three years later. This will depend, of course, in a measure on the nature of the fertilizer used. If, like nitrate of soda, it is immediately available, then results may be looked for sooner than if it is of the nature of barnyard manure which can only be used by the plant after thorough decomposition has taken place.

Potash.— This fertilizing constituent is always looked upon by fruit-growers as being very important. It is well to remember that tillage increases the amount of available potash in the soil. The principal sources of potash are the German potash salts, chief among which are kainit, muriate of potash and sulfate of potash. An available form of potash is that found in unleached, hard wood ashes. These should contain from four to eight per cent of potash, the amount depending upon the wood from which the ashes were derived and the way in which they were kept.

Phosphoric acid.— Plain superphosphate contains about sixteen per cent of phosphoric acid. This is usually applied at the rate of from two to three hundred pounds per acre. There are also several brands of bone fertilizers. These are sold as "treated" and "untreated." The untreated varieties give up phosphoric acid very slowly. The treated, on the other hand, are more or less immediately available.

The gist of the whole matter of fertilizing orchards consistently and sufficiently may be expressed as follows: Luxuriant growth probably means abundant nitrogen. Stunted growth calls for nitrogen or water, or both. Fruit deficient in color and flavor suggests the freer use of phosphoric acid and potash; but without humus in the soil, the use of commercial fertilizers may be an extravagant if not useless practice.

The following bulletins on orcharding have been issued by the Cornell Agricultural Experiment Station, copies of which are available: 72, "The Cultivation of Orchards;" 102 and 103, "General Observations on the Care of Fruit Trees and Soil Depletion;" 153, "Impressions of Fruit Growing."

CORNELL READING-COURSE FOR FARMERS.

QUIZ ON READING-LESSON NO. 13.

JANUARY, 1901.

BY JOHN CRAIG.

These questions constitute a supplement to Reading Lesson No. 13 (Orcharding: management of the orchard). Its purpose is to induce the reader to think carefully about what he reads. Answer the questions as best you can and return this sheet to us (2 cents postage). We want these answers in order that we may know what interest you are taking in the Reading-Course and how much good you are getting from it; and we want to help you when you do not understand the problems involved. We are after results, and do not care about the handwriting nor the grammar. These answers are for our own examination and are not to be made public. We should be glad of any comments on these lessons.

It is hoped that readers will form themselves into little clubs, to meet once or twice a month to discuss the problems raised by the lessons.

Those who answer the questions will receive future lessons.

A Lesson giving correct answers to the questions asked on Lessons 11–15 will be issued at the close of the season.

1. What do you mean when you speak of a fertile soil?

2. What do you consider to be the most important effect of good tillage on the soil?

3. Why does not the amount of plant-food, which chemical analysis shows that a soil contains, always indicate the crop producing power of the soil? Explain fully.

4. Describe what you understand by thorough orchard tillage.

5. In what respect does the orchard (fruit trees) differ from the wheat crop?

6. Why is it unwise to grow cereal crops in an orchard?

7. Name two purposes which the orchard cover-crop is supposed to serve.

8. What advantage has the leguminous plant over the non-leguminous plant when used as a cover-crop?

9. If you are in need of nitrogen, unable to obtain barnyard manure, tankage, or other animal refuse and do not care to use chemical fertilizers, what might you do?

10. Name three nitrogen "collectors."

11. Name three nitrogen "consumers."

12. What is a superphosphate?

13. What should be added to green manures to make a balanced plant-food ration?

14. What system of orchard cultivation has given you best results?

15. What experiments have you tried, if any, with orchard cover-crops?

16. Mention any special farming problems in which you are particularly interested.

Name......................................

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CORNELL READING-COURSE FOR FARMERS.

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READING-LESSON

NO. 14.

FEBRUARY, 1901.

BY JOHN CRAIG.

Orcharding.

CARE OF THE TREE.

The fruit tree will not take care of itself even with the best of cultivation ; there are certain things that the grower must do, and chief among these is pruning.

I. PRUNING.

1. Fruit trees must be pruned.—If a tree in an open field is allowed to grow unpruned, the crown soon becomes a dense mass of

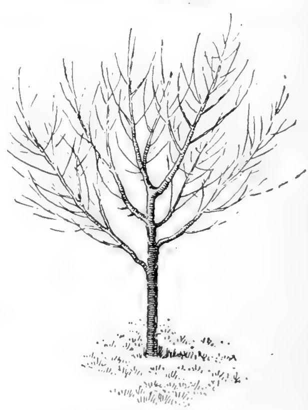
The sad story of the neglected orchard ; no tillage ; no pruning ; no spraying ; no fruit !

twigs and interlacing branches, the density depending somewhat on the variety. Now such a tree may produce as large a number of apples as a well pruned, open-headed tree, but will there be the same percent-

age of merchantable fruit? The chief effort of every plant under natural conditions is expended in ensuring its own reproduction. This is chiefly effected by means of seeds. A small apple may contain as many seeds as a large one or even more. The orchardist wants big fruits, and if they are nearly seedless so much the better. Large fruit may be secured by reducing the unproductive parts of the top to a minimum and by providing the roots with plenty of available food.


Top too dense.

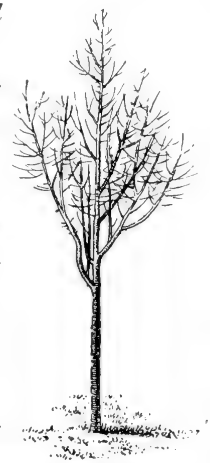
2. Nature prunes but in a slow and imperfect way.— Only a small number of the total shoots produced on a young apple tree reach twig size, and a much smaller number attain the dignity of medium sized branches. There is a sharp struggle for existence; many buds are crowded out by others more favorably situated with regard to food supply. There is a waste of energy while this struggle for supremacy is going on; the fruit-grower prunes to husband the energies of the tree so that larger and better fruit may be produced. The amount of pruning necessary in orcharding varies with location and exposure. In hot exposed situations fruit trees do not need as much pruning as in sheltered cool sites. Sunshine and light are essential to the development of well colored, high flavored fruit. In the East there is more cloudy weather and less intense heat than in the West. More pruning is needed. The quality of the fruit produced may be accepted as an indication of the tree's requirements in the way of pruning.


Same top pruned.

3. By pruning certain definite purposes may be accomplished.— Bad habits may be corrected; defi-

nite shapes may be secured. It has been shown that nature prunes; that is to say, certain parts of the tree are crowded out of existence; they wither and fall away. But man, the gardener, may wish to reach specific results quickly. The tree may be slow in coming into bearing; its growth may be weakly; it may be over luxuriant. These defects may be largely corrected by judicious pruning.

4. The vigor of the tree may be augmented by pruning the top.— In "The Pruning Book" page 12, Bailey says that "there is an exact balance between the feeding capacity of the plant, that is, its root system and food supply, and the superficial growth of the plant. The more active and efficient the root the larger the top. If we remove a large portion of the top there is an endeavor to supply the deficiency by an exceedingly rapid growth." The more or less constant food supply is distributed over a smaller area — a concentration takes place and rapid growth results.



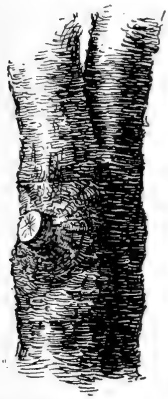
The crown (head) of this tree needs thinning.

5. *Heavy pruning in winter encourages wood production while summer pruning discourages wood growth and encourages fruit production.*— The old adage runs, "for wood, prune in winter, for fruit, prune in summer." We have already seen why winter pruning induces wood growth. Why summer pruning encourages the development of fruit-buds is not so clear. In methods it differs materially. Winter pruning to increase vigor removes large branches; summer pruning only pinches the growing points. The object of the latter is to lessen the number of digestive organs (the leaves) so that wood growth may be checked. This pinching should take place about midsummer; if done too early wood growth is stimulated, if too late the buds may not develop. Decisive results should not be looked for from this method. It is essentially a gardener's practice and hardly applicable to orchard areas.

How it may be thinned.

6. All fruit-bearing plants cannot be pruned alike. Special practices are employed for the purpose of securing certain specific results.

Heading in: — We have already noted that very strong growth is often made at the expense of fruit-bearing. Peaches, plums and dwarf pears are "headed in" to encourge the development of fruit-buds by concentrating elaborated food. This system of pruning, which is done during the dormant season, and consists of cutting off the ends of the terminal shoots, may also be a means of thinning the fruit by removing fruit-buds. If the "heading-in" is severe and takes the form of a heavy pruning, one of the objects of the work may be defeated — a vigorous growth may be induced. The operator should study the condition of the tree and exercise his best judgment.



The long stub does not heal.

7. The wound made when a limb is removed heals best if the cut is made close to the trunk or branch on which it grows.— We have seen that leaves are the food-elaborating factories of the plant. If a branch is cut off, leaving a stump three or four inches long, quite bare of leaves or buds, what happens? Possibly the stump develops buds, and puts forth leaves which set to work to repair the injury. Suppose that no leaves develop (perhaps the branch was feeble) then what happens? The stump becomes "side-tracked," the water going up and the elaborated food coming down, pass by, and no healing takes place. The cut surface is not covered by a protecting callus, germs of decay find entrance and rot sets in resulting in the destruction of the wood, not only in the stub itself, but following its fibers into the heart of the parent tree. If the branch is severed close to the main stem the vitality of the wood is preserved and the wound is covered before decay sets in.

Close cutting results in prompt healing.

8. The healing of wounds is facilitated by protecting them from moisture.— The decay of wood is caused by the growth of bacteria, fungi and other parasitic organisms. Moisture is necessary to the germination of these organisms. If the exposed surfaces made by heavy pruning are covered with water-proof paint or some antiseptic dressing, the germs and spores of these wood-destroying parasites are kept out. Very cheap substances are quite effective; among these are lead, paint, tar and Bordeaux mixture. They should be applied promptly after the wound is made.

The pruning of grapes, raspberries, gooseberries and currants are matters of special detail. The habits of the plant must be known and the pruner should ask himself in each instance what the particular result is, which he is aiming to secure.

II. Insects and Diseases.

9. There are enemies which the fruit-grower must fight and conquer if he would succeed in business.— Whenever certain classes of plants are cultivated exclusively or largely in any one locality, the insects which feed on them multiply with great rapidity. The conditions for the growth of these insects are more favorable than formerly, food is plenty and the rate of development is out of proportion to the increase of the food product. In all great fruit centers, therefore, special methods are employed to destroy the enemies of economic plants — that is, those plants useful to man.

10. Enemies of the orchard are divisible into two classes: those which belong to the animal kingdom; and those which are members of the vegetable kingdom. The methods of treating these enemies are based on their structure, habits of growth and the manner in which they attack plants.

(a) *Insect enemies.*— Insects which have jaws with which they bite or chew the parts of the plant may be destroyed by sprinkling the plant on which they feed with substances which are poisonous when taken internally. This class of insects is usually the most important one with which the farmer has to deal. To it belong the potato beetle, the canker-worm that defoliates apple trees, the army-worm, the larvæ (worms) of the codling-moth, the currant worm and numerous beetles. Chief among poisons used against

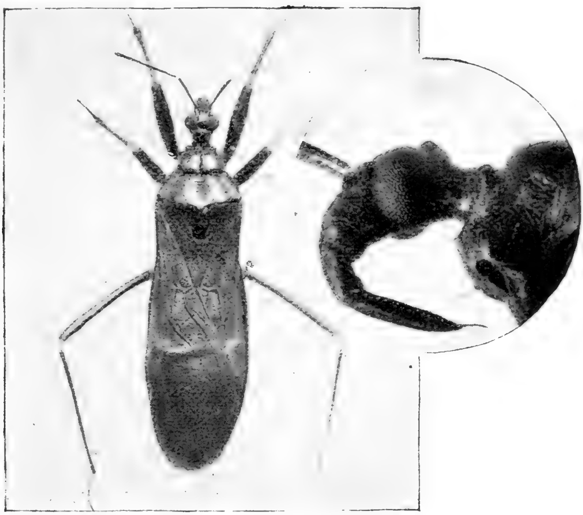
this class of injurious insects are those which contain arsenic as the poisonous principle. When properly prepared their efficacy depends upon the thoroughness of the application. The insect attacks the foliage, it eats the poison which is sprayed upon the leaves, and in this way it is destroyed. It follows, therefore, that only thorough applications are likely to be satisfactory. Among the poisonous substances used, Paris green is the commonest. This is found in various forms. Arsenic is the poisonous principle in its composition. Other forms of arsenical poison are London purple, paragrene and arsenite of soda or lime. The application of these poisonous materials has developed into a well-defined practice in the last few years. There are two thoughts to be kept in mind. (1) Thoroughness of application, and (2), economy. The proper mixing of the materials and their application to the trees are matters which are regulated by judgment and good spraying pumps.

11. There is another class of insects which obtain their food by sucking the juices or sap from the plant which they infest.— This class of insects is very important. They are very minute. They are not supplied with jaws with which to chew or eat their food; instead they have a sucking tube with which the juices of the plant are extracted. As examples we have the great number of lice infesting house plants and field crops. To this sucking class also belong the many injurious scales, such as oyster-shell bark-scale, scurfy scale and San José scale. These insects are destroyed by applying either caustic or oily substances which injure their bodies, or which may produce suffocation. The sprays are

The currant worm is a leaf-eating, that is, a biting or chewing insect.

thrown over the plant or tree which they infest by means of a force pump equipped with hose and a suitable nozzle. In spraying these sucking insects only those that are hit by the spray are killed therefore be thorough.

12. Fungous diseases or plant parasites, with which the orchardist has to deal, are a low class of plants which are unable to use directly the raw food materials of the soil and the air. They live on the prepared food manufactured by higher and better organized plants.



The "kissing bug" is a sucking insect. Enlarged sucking tube at the right.

(b) *Fungi* (singular fungus).— A fungus is a general term applied to certain plants of low organization, some of which live as parasites on other plants, and is called a plant disease. Fungi are very numerous and vary remarkably in appearance and character of growth. Fungi are sometimes called flowerless plants in contradistinction to the flowering plants. They produce no flowers, and, therefore, no seed like those of the flowering plants. Their reproductive bodies are called spores. How many farmers' boys have wondered of what the cloud of brown smoke was composed

that floated away when they played football with a mature puff ball in the cow pasture? This smoky powder is composed of innumerable small bodies called spores. The toad stool is one of the highest representatives of this great tribe of flowerless plants. The majority of the plants of this class are small and inconspicuous. Farmers detect their presence rather by their injurious effects than by the recognition of the individual plant.

13. A fungus may grow on the surface of the host plant (the plant upon which it feeds) or it may grow beneath the surface and within its tissues.—We have, therefore, two classes of fungous enemies, in a broad way: the surface feeders and the internal feeders. The "smuts" of corn, oats and wheat, the "black knot" of the plum and cherry are examples of the deep-seated class, while the mildew of the gooseberry and the cherry are common examples of the surface-feeding types.

14. Spores, like seeds, germinate under the influence of favorable conditions of heat and moisture, and the plant parasite works or grows from the outside inwards.—The way in which spores germinate and become established on the host plant gives a clew to the best methods of fighting this type of enemy. The spore must either be killed or its germination prevented. Experiment Station workers and fruit-growers found years ago that soaking wheat in blue stone would largely prevent smut. Blue stone, or blue vitriol, known to chemists by the name of copper sulfate, is now recognized as the base of the most valuable fungicide in use. This fungicide is called Bordeaux mixture. Full instructions for its preparation and use are given in Bulletin 114, Cornell University Experiment Station. To prevent the germination of the spores which give rise to the plant disease causing the spots and scabs on apples, the trees are completely covered in early spring with a spray of Bordeaux mixture. The more complete the covering, provided it is applied before growth begins in the spring, the cleaner will be the fruit and foliage. These sprayings are repeated during the spring and early summer.

15. Plant parasites of the orchard usually infest both fruit and foliage.— Spraying is an insurance. The grower may, and often

does, think that because there is no fruit, he need not spray. It is even more important to keep the digestive agents, the leaves, in good working order, than it is to protect the fruit, for unless these perform their function of manufacturing starch, the prospects of a crop of fruit the following season are but slight. Therefore, spray to save the fruit crop of this year and to insure that of the year to come.

III. Thinning.

16. A large number of apples or pears are often produced at the expense of size and quality.—A fruit grower writes, "My trees hung full of apples but they were small." Another says, "As my peach trees grow older the peaches become smaller each year." The size of the fruit is an expression of the vigor and health of the tree. A bushel of apples may contain from one hundred to two hundred specimens. A tree begins growth in the spring with a more or less fixed amount of energy and is influenced one way or the other, strengthened or weakened, by the soil and weather. If five hundred apples represents the maximum crop which a tree can mature under favorable circumstances, is it not reasonable to suppose that if one-third of these apples are removed the remainder will receive that much more food and increase in size accordingly? This has been proved by actual experiment.

The next consideration is a financial one. The fine product always sells best. The second and third rate article cannot be handled with profit. Peaches, plums and pears are now systematically thinned by our best fruit-growers, and the labor is more than paid for by the results secured. Sooner or later the fruit must be picked; it really costs no more to pick part of it in June than in September.

CORNELL READING-COURSE FOR FARMERS.

QUIZ ON READING-LESSON NO. 14.
FEBRUARY, 1901.

BY JOHN CRAIG.

These questions constitute a supplement to Reading Lesson No. 14 ("Orcharding: care of the tree"). Its purpose is to induce the reader to think carefully about what he reads. Answer the questions as best you can and return this sheet to us (2 cents postage). We want these answers in order that we may know what interest you are taking in the Reading-Course and how much good you are getting from it; and we want to help you when you do not understand the problems involved. We are after results, and do not care about the handwriting or the grammar. These answers are for our own examination and are not to be made public. We should be glad of any comments on these lessons. Those who answer the questions will receive future Lessons.

You may not be able at first to see the point to some of the questions. It is the purpose of these questions to set you to thinking about the problem in hand, rather than to find out all that you know about the subject.

When the reading season is over, we hope to send you a Lesson containing correct answers to all the questions in the five Lessons.

We have prepared a Reading-Course for farmers' wives and women farmers. We shall be glad to receive applications for admission to this course which is also free.

1. How does nature prune trees?

2. Why is it better to prune annually than at periods of four or five years?

3. How may pruning increase the growth of wood?

4. How may fruit production be influenced by pruning?

5. Why should you always cut close to the main branch or trunk in pruning off a superfluous branch?

6. Why is it desirable to cover the wound with paint or grafting wax.

7. How would you control the canker-worm?

8. Give examples of sucking insects.

9. How would you treat plants infested with aphids (plant lice)? They are found usually on the under side of the leaf. Plums, cherries, apples, snowballs are infested.

10. How should arsenical poisons be applied?

11. How is kerosene emulsion made and what is it used for?

12. What is a fungicide?

13. What are the ingredients of Bordeaux mixture?

14. What is a plant parasite?

15. How may the size of fruit be increased other than by feeding pruning and spraying the plant?

Name..............................

Address ....

Date..............................

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READING-LESSON

NO. 15.

MARCH, 1901.

BY JOHN CRAIG.

Orcharding.

HANDLING THE FRUIT.

The fruit tree is an investment; the fruit should prove an annual dividend.— It is within reasonable limits to say that by the time a well cared for Baldwin apple tree reaches bearing age it may

A busy day among the Baldwins.

represent an investment of labor and capital amounting to ten or fifteen dollars. In most parts of New York State this investment is fairly sure and will yield large dividends under good management. The principal essentials to success have been outlined in the preceding four Lessons of this series. The dividend may yet be

lost if the owner neglects to exercise intelligence and judgment in picking and handling the fruit. The method of handling the fruit crop is of vital importance. It is the climax of years of labor; yet just here many fruit growers fail.

The keeping qualities of the fruit are influenced by the time of picking.— An apple may be mature when the seeds are colored but yet not ripe from the eater's standpoint. After it is mature the ripening process will go on more rapidly if the fruit remains on the tree than if it has been picked and stored in a cool place. If exposed to the sun or stored in a warm room it continues to ripen more or less rapidly, depending on the warmth of the room. Apples that are exposed to the sun for some time after picking or are allowed to hang on the trees late in the season may be somewhat improved in flavor and appearance, but their season of keeping is undoubtedly shortened.

The ripening and decay of fruits follow each other without any clearly defined dividing line.— Fruits develop, mature, ripen and decay in shorter or longer period according to their characteristics and the manner in which they have been handled and stored. The whole process of ripening under normal conditions is regularly continuous and is not divided by clearly marked intervals. An apple loses crispness, becomes mellow, the cells break down and the apple is rotten. While these changes are due to different agents as chemical action and growth of microbes the process is quite gradual. A peach is picked when still hard, but in a temperature of 50 degrees F., or above, soon becomes soft and in a few days is reduced to a mushy mass of pulp. If picked when ripe and beginning to soften, the life of the fruit is, therefore, relatively shorter than if picked when just mature. In winter fruits the ripening (mellowing) process goes on slower than in the summer varieties.

The decay of fruits is due to certain ferments, chemical agents and micro-organisms which develop under favorable conditions of temperature.— The ordinary keeping season of fruit may be much prolonged by storing it in a compartment in which a low temperature may be preserved. The germs which may bring about the decay of fruits like those which change grape juice from the sweet

stage to the alcoholic can only develop when the temperature is considerably above freezing. It follows, therefore, that if fruit is stored in a chamber where the temperature can be kept near the freezing point, germs of fermentation or decay will not develop and the fruit will remain in an inactive condition; in other words, the ripening process which precedes the decaying process does not go on. On this principle is founded the practice of placing fruits in cold storage.

All farmers and fruit growers cannot afford to erect elaborate storing houses, but it will pay most fruit growers to put up storage

Sorting and packing in the orchard.

houses in which their perishable fruits may be safely stored at times when the market presents unfavorable selling opportunities. When fruit growers are entirely without storehouses they are practically at the mercy of the buyer and the fluctuating market prices. It was due to this fact that much of the 1900 apple crop of Western New York was sold at low if not unremunerative rates.

Bruises shorten the keeping season of fruit.— Fruit pickers seldom realize how much the normal keeping season of a fruit is shortened by bruises due to careless, indifferent handling. When the flesh of an apple is bruised, the cells are crushed, the juices are

liberated and ferments giving rise to decay develop. The life of an apple, peach or pear depends very much on the care used in picking it. When fruit is shaken from the tree or thrown carelessly into a hard-bottomed or rough-sided basket, dumped into a wagon box, or transported in sacks like potatoes, as they were in former days, the keeping season is shortened and the percentage of loss on stored fruit is very great. Mature fruit should be handled as carefully as thin-shelled eggs. The picker can soon train himself to handle fruit gently if he takes the slightest interest in his work.

Grading at store house. Note padded baskets.

Suitable receptacles for picking the fruit are important.—There are two kinds of picking receptacles in common use among fruit growers. One is a swing-handled basket which allows of the contents being gently emptied into the barrel. This is a strong splint basket and should be padded or lined with burlap on the inside to prevent bruising the fruit. The second type of picking receptacle is a grain sack into the mouth of which is fixed a hoop; or a stout bent stick may be placed across the mouth, making a triangular opening. A broad leather or canvas web strap is then connected

to one of the lower corners of the sack. An iron ring is attached to the mouth to which is snapped the strap. The sack is suspended from the picker's shoulder by means of the strap. This sort of device allows the picker to use both hands. Having the sack easily detachable the picker can gently empty the contents into the barrel without injury to the fruit. Early apples and all soft fruits, such as pears, plums and peaches, should be picked in baskets and taken directly to the packing room for sorting.

Grading is absolutely essential.— The grain merchant cannot afford to place ungraded wheat on the market; neither can the fruit grower afford to mix No. 2 with No. 1 apples in the same package. It does not pay the fruit grower to place on the market mixed grades of apples. Whether he is shipping apples or strawberries, the same principle applies. The price is fixed by the smallest fruit in the package rather than by the largest. An even grade, whether of small, medium or large size, is more attractive to the purchaser than one containing many sizes. The grading of the fruit is an important piece of work. Very few persons can do it satisfactorily. It is not mechanical work, but work that requires quick judgment, a keen eye and a conscience. Fruit can best be graded in the packing house. This is particularly true of the tender types of fruits. In apple orchards where the yield is heavy the work may be done on movable grading tables in the orchard. Some packers pour the picked apples on the ground and sort from thence directly into the barrels. The best work can be done where the best facilities are offered. Make-shift methods usually result in unsatisfactory and uncertain grades. A tempting display of produce attracts buyers and develops a market. The market is best maintained by practicing strictly honest methods. Fruit in the center of the package should be as good as that on the surface.

The best goods are done up in small packages.— The purchaser is usually willing to pay for an attractive package and the selling qualities of the fruit are greatly increased thereby. As a general principle, the finer the quality of fruit the smaller should be the package. Staple articles and standard varieties are shipped in bulk, but " fine goods are done up in small packages." The barrel is the

standard package for the commercial varieties of apples thus far. The finer, earlier and tenderer varieties of apples are often shipped with greater profit in baskets and attractive small boxes than in barrels; but only the finest fruit and that which is most carefully graded should be handled in this way.

Changes of temperature cause moisture and hasten decay.—If the fruit after packing is brought from a warm temperature to a cold one or from a cold one to a warm one, moisture is condensed on the surface. This is what is called "sweating" and may readily be observed when apples are exposed to sudden and marked changes of

A grading table with storehouse in background.

temperature. Apples piled on the ground will develop heat to some degree which naturally encourages condensation of moisture. It is desirable, therefore, that if fruit is to go into cold storage it should be cooled gradually. In taking it from the low temperature of the storage chamber to a warm room the change should also be a gradual one. If this precaution is not taken the fruit becomes wet on the surface and presents favorable opportunities for the development of germs causing decay.

The fruit grower frequently finds it desirable to store his fruit after picking until more favorable market conditions occur; but only sound clean fruit should be packed. He often fails to appreciate the fact that various kinds of vegetable parasites (fungi), spoken of in Lesson 14, are as likely to continue growth on the fruit in ordinary storage as on the fruit before picking. The greatest care should be exercised in barreling this fruit, to see that it is free from scab, bitter rot, fly-speck fungus or any other vegetable parasite. Pickers are often surprised on opening the barrels in midwinter to find that there is considerable waste in fruit which appeared moderately fair and clean when packed in the fall. This

The depot packing house.

impresses the lesson that at the first packing every blemished specimen should be rejected. It is economy to do this in the long run. Not only is it wise to reject specimens affected by scabs and spots but also those infested by insects, because the larvæ of codling moths for instance may continue the destruction of barreled fruit where temperature is not very low.

Early fruits should be picked successively.— Pears and apples should not be pulled from the tree. This way of pulling often

separates the stem from the fruit and injures the appearance and keeping qualities. Apple and pears, when ready for picking, may be separated from the spurs, to which they are attached, by turning the fruit upwards. This knack is quickly mastered by deft-handed pickers. As a rule pears ripen more satisfactorily in the storehouse than on the tree. Bartletts may be picked before reaching maturity and if stored in a cool darkened room will become more rich and buttery than if left on the tree. Loss of pears from rotting at the core may be obviated in large measure by early picking. Sometimes it pays to remove the fruit of certain varieties in two or three successive pickings. This is particularly true of early varieties of apples, pears and peaches. A prominent apple grower in this State makes a specialty of Oldenburg (Duchess) apples. In order to get the most out of the crop the trees are thinned of their largest fruits as soon as salable size is reached. The operation is repeated when another picking is ready. In this way finer fruit is secured and larger returns obtained for the entire crop than would be possible if the fruit was all removed at one picking.

Handle soft fruits very carefully.— Plums and cherries are picked with stems on. The picker should grasp the stem and take care not to separate it from the fruit as this encourages rot. In picking peaches the fruit should be seized firmly with ball of thumb and inside (not ends) of fingers and detached by turning it to one side. Strawberries should be without white tips and fully colored when picked. The stem is pinched off by the finger and thumb. Raspberries, blackberries and dewberries are of course picked without hulls, although when a fancy trade is catered to, red raspberries are sometimes picked with hulls on. In picking currants the entire cluster should be removed. In every case, the picker should use his best endeavor to preserve the natural bloom of the fruit which adds so much to its beauty.

A fruit house should be so constructed as to preserve an even temperature.— Storage houses are of two types: First, those which modify but do not regulate extremes of temperature, and second, those which furnish definite low temperatures. Houses of the first class are generally within the means of the commercial fruit grower.

Those of the second belong to the equipment of the fruit dealer. The ordinary storage house is probably a frame building provided with a well drained cellar and having perfectly insulated walls and double doors. Insulation is secured by providing two or more air spaces in the walls. These air spaces should be separated by paper-covered partitions. Comparatively low temperatures in these buildings may be secured in the fall by keeping them tightly closed during the warm part of the day and ventilating only on cool nights. Fruit houses of this character will also keep out frost so that the grower may hold his fruit till a favorable opportunity for selling occurs. Dry air prevents the growth of fungi but causes the fruit to shrivel; a moist atmosphere on the other hand preserves the plumpness of the fruit but encourages the development of parasitic plants. Extremes should be avoided.

The principal thoughts for the fruit grower to keep in mind in handling his fruit are that it is a perishable article, that its keeping season may be lengthened by careful handling and by low even temperature, and that profits may be increased by placing it on the market in an attractive form.

CORNELL READING-COURSE FOR FARMERS.

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SUPPLEMENT TO READING-LESSON NO. 15.

APRIL, 1901.

BY JOHN CRAIG.

Dear Reader :

I am writing this letter, which I hope you will accept as a personal one, to give you a word of greeting at the close of the Reading season and also to tell you of a disappointment just experienced.

The orcharding series.— But before we speak of disappointments, let us talk of the good work we have accomplished during the winter. In writing the series of lessons on ORCHARDING it was keenly felt that the subject could be considered only in the most general way; that to the experienced fruit-grower the Lessons could only be regarded as superficial reviews while the specialist might get little or nothing from them. Nevertheless, I hope, and in fact have reason to believe, that some light has been thrown on the principles of fruit-growing, that a fairly definite knowledge of the needs of a fruit tree may be gained by a study of these Lessons, and that an intelligent view of the orchard as a farm crop, demanding careful attention each year, has been given. There is health, enjoyment and moderate remuneration in fruit growing, but, like general agriculture, the enjoyment and financial returns are generally proportionate to the amount of study, thought and general attention put into the work. Few men fail if they bring to bear on the work these essentials and if they give it diligent attention.

The neglected orchard.— I am wondering if these lessons gave us any new notions. Do any of us own neglected orchards? Shall we prune, and are we planning to spray, cultivate and fertilize these old trees? In their present condition they are unprofitable cumberers of the ground. We do not like to chop them down, but they occupy good land. Give them another trial. Ask for suggestions. You have capital invested in these trees and should secure an annual return.

Perhaps you are considering the question of setting out a new

orchard. Here again we should like to help you if we may. Be sure to prepare your ground thoroughly and then choose the right varieties.

And now for our disappointment.— We promised to send you the correct answers to all questions asked on the previous five Lessons. It grieves me to say that we find this to be impossible. The expense of printing and mailing lessons to twenty-seven thousand readers has been considerable, and we find ourselves unable to carry out our intentions at this time. Next fall, however, this "round up Lesson," the close of the Cornell Reading-Course so far as it has been planned at present — in fact probably as far as our funds will allow us to carry it — will be sent to you with the hope that it will find you balancing a very satisfactory set of season's accounts.

Winter course in agriculture.— You have completed the Reading-Course, but there is another Course open to you by the appropriation for *Extension work in agriculture.* This is the short *winter Course in agriculture* at Cornell University. It is the logical and fitting finish of the Farmers' Reading-Course. To many of our older readers it will be impracticable, but what about the young men, fresh from school who are as yet wavering in regard to choosing a life vocation? Send them to us. The expense is practically the cost of living. The inspiration they will receive we feel sure will bring them back to the farm with a new conviction that there is dignity, happiness and competence in farming, which are to be gained by the application of intelligence and by perseverance. For further information consult Lesson 11 or write to the undersigned.

Experimentation.— Remember that the Reading-Lessons are for the season of study and reflection — the winter. In the summer we are ready for coöperative experiments, with fertilizers on your farms, studies of cultural methods and means of combating insects and fungous enemies in your orchards.

We shall be glad to hear from you on this side of your farm work at an early date, so that we can plan for the summer campaign.

With best wishes for a profitable season, I am,

Yours faithfully,

JOHN CRAIG.

CORNELL READING-COURSE FOR FARMERS.

QUIZ ON READING-LESSON NO. 15.

MARCH, 1901.

BY JOHN CRAIG.

These questions constitute a supplement to Reading Lesson No. 15 ("Orcharding: care of the fruit"). Its purpose is to induce the reader to think carefully about what he reads. Answer the questions as best you can and return this sheet to us (2 cents postage). We want these answers in order that we may know what interest

The box and barrel package.

you are taking in the Reading-Course and how much good you are getting from it; and we want to help you when you do not understand the problems involved. We are after results, and do not care about the handwriting or the grammar. These answers are for our own examination and are not to be made public. We should be glad of any comments on these lessons. Those who answer the questions will receive future Lessons.

You may not be able at first to see the point to some of the ques-

tions. It is the purpose of these questions to set you to thinking about the problem in hand, rather than to find out all that you know about the subject. This lesson closes the third series in our course.

We have prepared a Reading-Course for farmers' wives and women farmers. We shall be glad to receive applications for admission to this course which is also free.

1. Why does a low temperature preserve fruits better than a high one?

2. Why is it a bad policy to store diseased fruit with sound fruit?

3. How would you handle a crop of summer apples provided you had a good market with desirable shipping facilities within easy reach?

4. Give your ideas as to the best methods of picking and handling winter apples.

5. What types of fruits should be handled with great care and be packed in small packages?

6. Describe an apple which you would grade as No. 1.

7. Describe an apple which you would grade as No. 2 of the same variety.

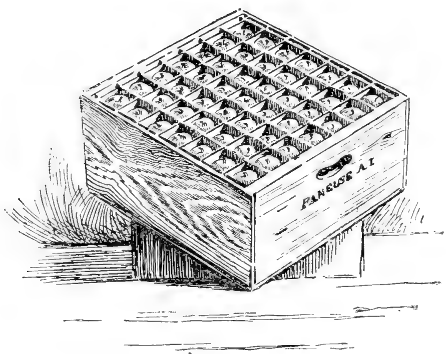
8. What conditions would justify a farmer in erecting a storage house for fruits?

9. If your plums, cherries or peaches were severely attacked by rot when near ripe, what would you do?

10. Give any observations you have made in handling and marketing fruits.

Name....................................

Address..............................



Compartment box

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SUPPLEMENT TO READING-LESSON NO. 6.

APRIL, 1901.

BY JOHN CRAIG.

Dear Reader:

You have been studying the soil and one of its products, the plant. The farmer's season of study and reflection is over for another year and his period of greatest activity is come.

Have these Lessons on the soil and the plant suggested new methods of managing your fields, different ways of handling your plants or a more effective plan of maintaining the fertility of the soil? If they have not done any of these things, but have given you more interest in the ordinary and sometimes tedious details of farm work, they will not have been issued in vain.

We hope that you will find knowing the *why* more valuable than simply knowing the *how*. Given the why, the how comes easily. We hope that the Lessons have interested you as much as your answers have interested us. We have not been able for lack of time and means to acknowledge and comment on each reply but this omission is made up, in part, at least, by the Lesson accompanying this. Compare the answers with your mental picture of those you submitted and in this way obtain a review of the series.

It is easy to make plans for next winter, but the prudent man is always forehanded. I wish to speak about our WINTER COURSE in AGRICULTURE for FARMERS and their BOYS and GIRLS. This course begins in January and continues for eleven weeks. It is packed full of practical information. It is free to the farmers of the State and cannot fail to prove a wise investment of time for all who can so arrange affairs as to allow them to participate in it. Application blanks and full information may be had on application to the undersigned.

One of the objects of the Reading-Course enterprise is to encourage the spirit of inquiry and investigation in the farmer. To this

end we shall be glad to CO-OPERATE with him in CONDUCTING EXPERIMENTS which are designed to illustrate principles, discover new facts, or overcome prevailing difficulties.

Let us hear from you so that we may have an opportunity of initiating experiments of value in your locality.

Wishing you a prosperous season, believe me,

Yours faithfully,

JOHN CRAIG.

October, 1900.

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VOL II. CORNELL UNIVERSITY, ITHACA, N. Y. NO. 9

AUTUMN LEAVES.

ON the hills the leaves are coloring. Gradually the summer greens are turning to red and gold. The October haze is on the fields. The sky is near. Stillness is in the air. The year is ripe.

I see the pageant along the countryside, like a procession stretching away to paradise. There are kings and queens in purple and silver and gold. There are people in green and buff and brown. There are children in red and pink and yellow. My eyes are drunk with color.

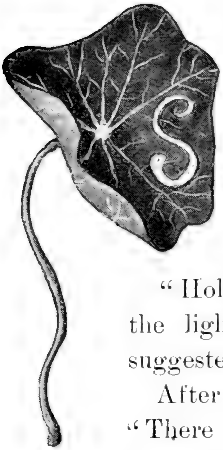
Over the fields and in the swamps I wander. I smell the weedy odor of the Indian summer. Yellow and fiery-red are the maples. Red and morocco-red are the oaks. Nut-brown are the beeches. Straw-yellow are the grasses, and brown and sere are the weeds. Each kind has its color.

And yet there are colors on the maple in the meadow and other colors on the maple on the hill. The oak on one side of my doorway is maroon-red and that on the other side is veiny-yellow, and they have been the same in all the Octobers in which I have loved them. Each plant has its color.

Floating, sailing, turning, the autumn leaves drop one by one. Content I sit in silence, and let the colors fill my soul.

L. H. B.

THE ARTIST OF THE NASTURTIUM.



"And there's never a blade or a leaf too mean
To be some happy creature's palace."
—*Lowell.*

"SOME leaves have pictures of snakes on them," said little Jack as he presented me with a nasturtium boquet.

"Who makes the pictures?" I asked.

"Nobody," he responded promptly.

"Hold one of the leaves up between your eyes and the light and look at one of the snake pictures," I suggested.

After a moment of close observation he shouted: "There something alive in the head of the snake! I can see it move! What is it?"

I was obliged to confess that I did not know what it was. And so I concluded to ask the Junior Naturalists to help me find out the cause of these strange markings on the nasturtium leaves, and the way they are made. The questions, "What?" "How?" and "What for?" always confront the true naturalist.

I will tell you all that I know about these queer pictures on the nasturtium leaf; then I shall expect every true Junior Naturalist who has access to a nasturtium plant to help me discover the rest of the story.

All that I know is that this strange pattern in the leaf is made by a leaf miner, a very small insect that spends most of its life burrowing in the substance that lies between the upper and lower surfaces of the leaf.

The mother of the leaf miner has wings, but whether she has two or four wings, I do not know: if she is a fly she has two; if she is a moth she has four. Sometime during the summer she laid an egg on the leaf; from this egg there hatched a little larva, a worm-like creature, that began at once to burrow in the leaf. This is all I know.

Will the Junior Naturalists answer some or all of the following

questions, not by reading books nor by guessing, but by actual observations?

1st. Why does the insect make a mine in the leaf?

2d. How long does the miner live in the leaf?

3d. Why is one end of the mine larger than the other?

4th. Is the mature insect a fly or a moth?

5th. How does the mature insect escape from the mine? Is the hole through which it escapes in the upper or lower surface of the leaf?

6th. Do you find similar mines in the leaves of other plants than the nasturtium? If so, press some of these leaves and send them to us. (To Uncle John.)

7th. Make some drawings of the mines you find in nasturtium leaves and send them to us.

The way to capture the adult insect is to find leaves containing the living miners. Let these leaves remain on the plant and place over each a little bag of cheese cloth or thin muslin, and tie the mouth of the bag closely around the stem of the leaf. Thus when the winged insect emerges, it is caught in the bag and cannot fly away.

Send us any insects you have captured in this way. They may be put in a small pasteboard or wooden box and mailed to us. Wrap the box securely in strong paper. You will not need to provide air holes, for there will be air enough in the box.

Questions 1, 3, 4, 5, 6, 7, may be answered this autumn. But question 2 and possibly question 4 may be answered next summer.

If the Junior Naturalists complete this study it will be the first time the whole story of the nasturtium leaf miner has been told to the world. ANNA BOTSFORD COMSTOCK.

WHAT A YOUNG NATURALIST SAW.

It requires a long time for young people to become close observers but this is what you must do in order to make your work in nature-study successful. Look carefully at the out-of-door things which you most often meet, and make note of all that interests or puzzles

you. We fear that many of our Junior Naturalists do not send us a written account of their own observations, but try to make their letters read well by telling us facts which they have learned from others. We hope that you will not do this. We would rather have a few lines which tell of your personal interest in something in nature, than whole pages giving an account of the observations of other people.

If there were space in this lesson, we should publish a set of dues which were received this morning from an energetic club in Patchogue, N. Y. A physician in the village, who has an interest in young students, encouraged a number of high school boys to take work in nature-study. We feel that they have started out in the right way to become good nature lovers. As yet their work has in no way suggested that their information has been obtained from books. They have been out in the fields and woods and along the shore of Great South Bay; they have been interested in the natural objects about them, and they have sent us an account of their observations. One of the letters reads as follows:

PATCHOGUE, L. I., N. Y.

DEAR UNCLE JOHN:

As I was walking around one night up the street I saw that it was going to rain; so I started home. While I was passing a dark place I kicked a little branch of a tree and as I did so there was a funny noise made which I thought came from the branch so I picked it up and took it to the light where I soon found what it was. It was a bug about an inch and a quarter long and not quite as broad. It had two eyes that looked more like horns than anything else, although it had two little hair-like projections which I supposed to be some kind of horns. It has six legs on the under side. Back of the legs is a sort of creased abdomen which, lifted up a little when the bug is alive, will make him yell. There is a sort of bunch on his back between the roots of his wings. On his head is a sort of horn which enters a projecting part of his head. It has four transparent wings, which when both together look like a single pair only.

HERBERT WOODHULL.

The writer did not know that he had disturbed a sleepy cicada, but he took the trouble to find out what had made the peculiar sound. We are proud of this young naturalist and his associates for in all their work they have shown the spirit of personal investigation.

NOTES.

Junior Naturalists may write on any subject which interests them during the month, and their letters will be as satisfactory as though they had selected the topics suggested in the lesson.

* * *

Note the Autumn colors. Compare the colors of different kinds of plants. Compare different plants of the same kind. Are all hard maples colored alike?

* * *

Last year the members of the club sent ten or more seeds which they found traveling in search of new homes. Try this year to see how many you can find having different means of traveling. Notice whether they are fitted to float on the water, to be carried by the wind, or to ride on the snow. You may find some which are shot out of pods and in that way are sent some distance. Many cling to clothing or to the coats of animals. Find some of these seeds and tell us about them.

* * *

Crickets do not sing, although people often say that they do. Watch them closely and you will find that they make that pretty little chirping sound by means of musical instruments which they carry with them. You will have a good opportunity to study crickets if you keep them in a cage. Put some grasses in a flower jar and place a lamp chimney over them. Cover the top of the chimney with a piece of mosquito netting. You will then have a nice little house for the insect musicians. It will not be long before they will "chirp" as cheerfully as if they were in the field.

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VOL. II. CORNELL UNIVERSITY, ITHACA, N. Y. NO. 10.

A NOVEMBER WALK.

"Who said November's face was grim?" Not I, as I started out for a walk along the leaf-strewn path. The subdued tints about me and the soft gray sky above were restful after the splendor of October. Occasionally I felt a drop of rain. Was it to warn me that I would better go home? If so, the warning was unheeded. I was bent on reaching the open field and the woods.

I cannot say wherein lies the charm of an open field in November, but it is unmistakably there. I enjoyed every bit of the neglected land stretching on either side of the path. The teasels raised their heads defiantly, as if threatening all intruders, yet I wanted to stay among them. I had gone out, however, in search of galls, and as there were a few oaks among the trees in the distance I felt sure that I would find some there.

How silent the woods were! As I walked the rustle of the dead leaves seemed a most fitting sound, but one did not like to break the stillness. I leaned against a tree for a few minutes enjoying the feeling that for a time at least I was a part of the quiet outdoor world. The sky could be seen more plainly now that the leaves had fallen. Outlined against it were the strong naked branches. There was nothing to prevent the rain from falling on my face. I liked to feel it.

* * *

Oak galls are not difficult to find. They stand out on the old leaves or twigs ready to attract the attention of any young naturalist. There were two kinds on a near-by tree. The larger one, an "oak

apple," was old and brown — a deserted dwelling place. There was the small hole through which the inmate had escaped. Opening the other, a bullet gall, I found a fat little larva inside. No wonder he looked well cared for. He did not have to work for a living. His house had grown to accommodate him, and there was plenty of food within.

I wrote a brief description of the two galls, made note of the date and the place and took the specimens with me for further study. I wish the Naturalists would do the same.

* * *

As I was leaving the woods a breeze began to blow. The rain ceased. Heavy dark clouds moved over the sky. Some belated seed-travelers were swept along the path in front of me. The teasels swayed back and forth — a way they have of slinging their fruit. I delighted in the new aspect of the field. There was nothing grim about it.

"More welcome than voluptuous gales
  This keen, crisp air, as conscience clear;
November breathes no flattering tales,
  The plain truth-teller of the year.
Who wins her heart and he alone
Knows she has sweetness all her own."

SOMETHING ABOUT GALLS.

A gall is the snug little dwelling-place of an insect. You will think it very snug when you find one. Usually this small house grows about the larva as soon as it begins to feed on the plant, and a gall is formed instead of a perfect leaf or stem or branch. Knowing that our boys and girls will enjoy finding some of these interesting houses, I shall speak of them.

You know that a willow is a well-behaved tree, particularly the pretty little one that seems to love the stream; yet you will sometimes find it bearing cones when you do not expect it to bear anything but "pussies." Open one of these cones, and see whether the little tree has a good excuse for its strange conduct.

On the sweet briar rose bush you will find a round, spiny tene-

ment house. Put one of them into a bottle, close it with cotton instead of a cork, and I think that the tenants will come out some day.

Every Junior Naturalist is probably familiar with "oak apples." Tell me how they look inside. There is a small gall found on oak trees which has very thick walls. It is called a bullet gall. Find out whether the master is at home in this well-fortified dwelling.

WITCH-HAZEL.

How many members of the club ever tried to have a real friendly feeling for a tree? Have you been interested in its appearance, its life story, its surroundings? Have you noticed the changes in it as the days go by? If not, I wish that you would make one such friend this year and write to Uncle John about it. Any tree that you select will interest him. He will know some member of its family.

Recently I have become acquainted with a little witch-hazel tree which stands on the edge of a wood. It is very different in its habits from the trees about it. They have blossomed and borne fruit and are now prepared for a long rest during the cold weather. Not so the witch-hazel. For many weeks I have been watching its tiny buds open into pale yellow blossoms. Think of flowers venturing out in the cold autumn days! The first one appeared the 30th day of September. Now I am wondering when I shall see the last of the slender crinkled petals.

Perhaps the most wonderful thing about witch-hazel is the way it shoots its seeds out of pods. This is done in a most mysterious way, making one think that the little tree is a veritable wood-witch. A passer-by might easily be alarmed if he feels that some one is throwing stones at him, yet no one is to be seen in the woods. The seeds are formed from last year's flowers? Can you tell me how many there are in each pod?

NOTE-BOOKS.

We wish that the members of the club would have note-books and keep records of their observations. All naturalists do this. Here is a letter from a little girl who found out last year that it is a good thing to do:

WESTBURY STATION, N. Y., *March* 12, 1900.

DEAR UNCLE JOHN:

I have been looking to see how many kinds of birds I could see about my home. One warm morning I got up and went out of doors before breakfast. The first thing I heard was a little tapping on the locust tree. After looking around for some time I saw a little black and white woodpecker creeping around the tree. I think it is a downy woodpecker. After breakfast my brother and I saw a redheaded woodpecker and a flicker. They were getting worms out of the tree for their breakfast. I saw a good many chickerdees on the pear tree by the pond. Saturday we hung some fat on a tree by the school-room winder. I have seen two robins this year and some goldfinches. I have a little blank-book in which I am going to write the names of all the birds I see, also what I find out about them.

Yours truly,

ETHEL M. ALBERTSON, *Sec. of J. N. C.*

Uncle John hopes that many of the boys and girls will tell him about a walk that they have taken this month in search of galls. He will probably have one of the November dues published in the next issue of the Junior-Naturalist Monthly. It is always hard for him to select one from so many good letters, but he intends to put all that please him in a box and take one out with his eyes closed.

ALICE G. McCLOSKEY.

Witch-hazel in flower and fruit.

December, 1900.

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VOL. II. CORNELL UNIVERSITY, ITHACA, N. Y. NO. 11.

THE WAR AMONG THE TREES.

Not a sound was heard on the battlefield,— no firing of guns, no tramping of feet, no roar of cannon, no cry of victory. Neither the birds nor I felt the least fear even in the very midst of the strife. Rank upon rank along the stream stood the army, each soldier erect in his place. To be "as straight as a young sycamore," you must know, is to be very straight indeed, and every warrior on this battlefield was a young plane-tree. The conflict has been going on for years past; it will go on for years to come. Each winter will bring its time of peace; each summer will bring a renewal of the struggle.

Visiting a young forest is much like reading an interesting story of warfare. An army of trees contending for food, for sunshine, and for breathing space, stands before us. Can we tell, thus early in the history of the struggle, which are most likely to be the victors? This is the question that I asked as I stood among the plane-trees last summer; it is a question that I asked again as I walked among them this wintry afternoon. The trees are white-limbed and straight,— you cannot mistake them; yet two or three stand out unlike their fellows in vigor and in the power to hold their places in the struggle. Probably one of these two or three warriors will some day gladden the eye of the nature-lover, as the veteran plane-trees along the roadside do to-day. It will spread its branches to the north and to the south, to the east and to the west. Its bark will peel off. The cut-shaped base of the leaf-stalk will

cover the young buds. The fruit, crowded together in balls, will be suspended from the branches. Some of the seeds will become loose and float down the stream, others will sail through the air, while many of the buttonballs will remain on the tree long after the first snowfall. That these things may happen I have learned from the veteran plane-tree. Who better fitted to tell the story than the old soldier?

Suggestions for Study.

Plane-tree, Buttonwood, Buttonball, American Sycamore.

Describe the outer bark. The inner bark.

Notice the cut-shaped base of the leaf-stalk which covers the young buds.

Make a drawing of the buttonballs.

How are the seeds fitted for traveling?

Have you ever seen a buttonball floating down a stream?

How long does the fruit remain on the tree?

In the first lesson last year you learned what an akene is.

The seeds of the plane-trees are akenes. Can you tell why?

We would like to have some of the older Junior Naturalists study a young forest. You may not find sycamores near your home but you will probably find a young growth of other trees. Why should there be warfare among them? This may at first be difficult for boys and girls to understand. A little work in arithmetic will help you. Count the number of buttonballs which you find on the tree and the number of seeds in each ball. Perhaps this is asking too much, but if you even make an attempt to do this you will find what an immense number of seeds there are. Ninety per cent may fail to germinate, but do you think that there will be room for the remaining ten per cent? How could all get food and air and sunlight crowded so losely together? Some must perish. Since only a few can survive which do you think are most likely to live? Notice in how many ways the young trees differ one from another.

WINTER STUDY OF FISHES.*

The following letter suggests a topic for study this month:

TYRE, N. Y.

DEAR UNCLE JOHN:

I will try and tell you about some fishes we have here. We have bullheads, suckers, bass and pike and pickerel. We have caught a small fish and have it in our schoolroom to look at him and see him swimming around in the can which we have here. The can is a glass can and holds about a quart of water. Can you tell me how to keep minnows?

FLOYD CUDDEBACK.

It seems to me that it would be a good thing for all boys and girls to know as many fishes as Floyd knows; not only to become acquainted with them, but to be able to tell Uncle John how they know one from another. Let us study fishes this month and see what success we shall have in our work. All that you will need for your aquarium is a glass jar with some well-washed sand in the bottom of it. This may not be the best season of the year to go fishing, but some of the older Junior Naturalists will be able to get enough for you to study. Fish can be caught through holes in the ice. You can keep minnows and other small fishes alive for a long time by feeding them crackers or bits of bread. If you happen to have a bullhead in the jar, he will consider a small piece of meat worth eating.

This morning I had a good time watching fishes in an aquarium. The first one that I noticed looks something like a tadpole, with barbles on his head that make one think of pussy's whiskers, so the fishermen call him "tadpole-cat." He seemed to enjoy careering around a most dignified old sunfish, but the sunfish took no notice of him whatever. Scientists call this dignified fish *Eupomotis gibbosus* (pronounced *Eupomó-tis gibbó-sus*), but you may call him by the common name, "pumpkin-seed," if you wish. I am sure that he does not think there is much in a name.

---

* Our Leaflet No. 11 describes the aquarium.

If you have a sunfish in your aquarium, notice as it moves slowly about whether the fin on its back is long as compared with that of other fishes, and whether it is made up of the same kind of rays throughout its length. Notice, too, the way in which it pushes its mouth out when it eats. When a fish can push its mouth out in this way, zoölogists say it has a protractile mouth. Do you know any other fish which has a protractile mouth?

In an aquarium near the one graced by the presence of *Eupomotis gibbosus*, was a pet bass. It is the one which is called "small-mouthed black bass," but I do not believe the little fish which I saw go into its mouth thought it very small. This bass has become so tame that it will take a live fish from one's hand.

Some Things to Observe in the Study of Fishes.

The number of fins.

Where you find them on the body.

Of what use the fins are to the fish.

Whether the fins are similar throughout their length.

Where the mouth is situated. Some fishes can take food from the bed of the stream while others cannot. See whether you can tell from the position of the mouth where a fish must get its food.

How many nostrils do you find on a fish?

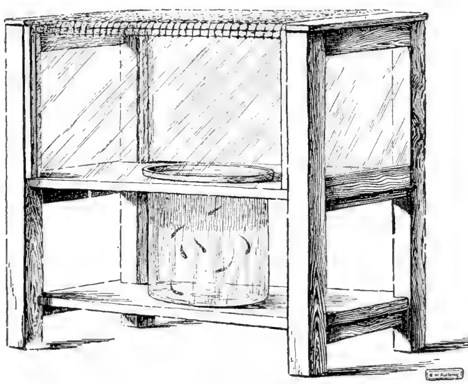
Zoölogists speak of the "lateral line" which is found on many fishes. Since it is called a lateral line it must be on the side, for *lateral* means *side*. Can you find a lateral line on any of the fishes in your aquarium?

HOW TO KEEP SALAMANDERS THROUGH THE WINTER.

Junior Naturalists frequently ask whether salamanders can be kept in the house all winter. Never having kept any I made some inquiries of the zoölogist. I found that he was the right person to consult, since he intends to have some in his laboratory all through the cold weather. He calls them salamanders, not lizards, for true lizards have scales like a snake and they are not found in the North.

The zoölogist used a great many big words in speaking of the salamanders. We do not need to learn them unless we want to. He said that they are amphibians, which means that they live in the water and on land. Since this is the case, we must make a cage for their winter home which will give them an opportunity to enjoy both. In the accompanying illustration one way of doing this is shown. Perhaps some Junior Naturalist can devise a better way. If so, I hope that he will tell some of the other members of the club about it.

There were two kinds of salamanders in the cage which we have shown in the picture. One was black with round yellow spots on each side of his back. He was introduced as Amblystoma. The other, a saucy looking little fellow, bears the name Diemic-tylus. His body was green above and lemon-yellow underneath. On either side was a row of scarlet spots, each surrounded by a black ring. Diemictylus was much more friendly than Amblystoma, and remained in my hand apparently quite contented for a long time. It is interesting to find that, as we become acquainted with these little creatures, they are no longer repulsive to us.



Winter quarters for salamanders.

A salamander is particular in regard to his food. He wants it alive. If you will put a small piece of meat on the end of a stick and move it back and forth in front of his eyes, he will condescend to eat it. Notice where his eyes are before you do this.

OTHER TOPICS.

Many topics may be taken up for the December lesson.

Where have the birds gone? What kinds remain and where do they roost?

Note the brook on the cold days. What parts of it freeze over first? Can you tell why?

Study the leafless twigs of the trees. Perhaps your teacher will give you a lesson from Leaflet No. 3.

In the first soft snowfall, notice how the snow is held on the different plants. Note the difference between the pine and the spruce in the holding of snow.

Where are the insects in December?

ALICE G. McCLOSKEY.

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VOL. II. CORNELL UNIVERSITY, ITHACA, N. Y. NO. 12.

THE SNOW STORM.

The wind blows. The bare branches of the trees creak. The icy snow flakes strike against the window and seem to call you out to enjoy the stormy January night. You think it would be fun to wrap up warmly and struggle against the wind for a little while, but you do not go. The wild night has a rival, a wood fire, which has a coaxing way of keeping you near it. It roars and crackles and sends gay little sparks out of the chimney. It does its best to make you forget the storm. As the fire roars louder and louder the tapping on the window seems fainter and after a time you cease to think of it.

The storm still decorates the landscape, however, while you sit indoors at your cheery fireside. In the morning you see the result of its work and you know that such an outdoor world has no rival. Every unsightly thing has disappeared. Yesterday you wished that the old ladder were not braced against the apple-tree; to-day you are glad it is there. Yesterday you objected to the clothes-line stretched across the garden; to-day you like to see the festoon between the grape-arbor and the tall white-capped post. Yesterday you wondered whether the mountain ash could be prettier than it was with its dusky background; to-day you know that it can.

You go into the woods. The stillness is almost solemn.

> "The pine is like a tall cathedral tower
> With oriels or withered ivy-vines
> Entwined in sculptured shapes of wreath and flower,
> Through which the clear, red stain of morning shines;
> And underneath, the snow-draped shrubs and briers
> Seem kneeling groups of silent, white-robed friars."

The poet does not speak of the persistent stems of the wood flowers, which stand erect and hold up the snow, but you notice them. Perhaps you find out what part of the plant is left to which the snow can cling.

As you walk on, past the spruces, which seem to hold their snowy burden lovingly, and past the indifferent pines, from which the soft covering is already beginning to fall, you notice that you are not the first traveler in the quiet, white-clad woods. Burroughs says: "The snow is a great tell-tale and blabs as effectually as it obliterates. I go into the woods and know all that has happened. I cross the fields and if only a mouse has visited her neighbor, the fact is chronicled." You find that is true. Here, the little tracks in sets of four give a clue to Mollie Cottontail's private affairs. There, underneath the oaks, the wild mice have been having a frolic. Their going and coming have been plainly marked. Your interest is awakened at once. You follow the foot-prints of these little wild creatures of the woods. Where were they scampering before you were up this bright morning?

* * *

The note of a chick-a-dee reaches your ear. This reminds you that the winter birds have not been very noisy to-day. A few are snuggled close together among the branches of the evergreens, but chick-a-dee is on the wing. Dear little bird! It is indeed "a cold day" when its cheery song is not heard. You do not wonder that Hezekiah Butterworth said:

"I love the high heart of the osprey,
  The meek heart of the thrush below,
The heart of the lark in the meadow,
  And the snowbird's heart in the snow;
But dearer to me,
Chick-a-dee! Chick-a-dee!
  Is that true little heart in the snow."

TRACKS IN THE SNOW.

Notice whether any grown people or little children have walked through your garden since the storm.

Can you tell whether Rover jumped over the fence or came in through the gateway?

Have the sparrows been near your kitchen door looking for crumbs? What queer little tracks they make! Do they hop or walk?

In the woods you will find the tracks of a rabbit. They are in sets of four, two being nearer together than the other two. Was he hopping slowly along? Did he stop to rest? Was he frightened at any time so that he took long leaps? Which way was Bunny going?

The smallest tracks of all are made by the wild mice. You will find them under trees. When they jump over the snow they drag their feet. You can see the little trails.

Hunters can tell by their tracks whether a dog, cat, fox, coon, or possum has passed. Can you?

I once heard of a man who knew whether a long-tailed weasel or a short-tailed weasel had been through the woods. How do you think he could tell?

Sketch some of the foot-prints in the snow. Tell us whether you found them under trees, by the banks of streams, or in the open. What creature made them?

* * *

In the fields and woods and along the roadsides notice how the snow clings to the old stalks of the wild flowers. Shake off the snow and see what part of the plant is left to hold it. Is it the leaves? The bowers? The seed-cups?

SOMETHING ABOUT A LITTLE WOOLLY BEAR.

In our monthly lessons we have frequently spoken of the value of keeping note-books. Have you tried it? During many years of his life Henry D. Thoreau, the great naturalist, kept a journal. The following was taken from one of the notes which he made January 8th, 1857:

"I picked up on the bare ice of the river a furry caterpillar, black at the two ends and red-brown in the middle, rolled into a ball of close rings, like a woodchuck. I pressed it hard between my fingers and found it frozen, put it into my hat, and when I took it out in the evening it soon began to stir, and at length crawled about, though a portion of it seemed not quite flexible. It took sometime for it to thaw. This is the fifth cold day, and it must have been frozen so long."

Now you are wondering, perhaps, how this little "woolly bear," as the caterpillar is sometimes called, came to be out of doors that cold day. It was the larva of an Isabella Tiger moth. This larva, instead of spinning a cocoon in which to rest during the winter as many larvæ do, crawls around in search of some cozy nook where it can sleep during the cold weather. You will occasionally find one of these caterpillars, which seems to have been over-particular about its hiding place and did not find any. In the spring the larva comes out and feeds for a time. Then it makes a blackish-brown cocoon out of its own hair. I hope if any of you find a larva of the Isabella Tiger moth you will tell Uncle John about it.

EVERGREENS.

How many kinds of evergreens are there near your home?

How do they differ in shape and size?

In pines the leaves are borne in clusters. Find the number in each cluster.

Describe the cone. Make a drawing of one of the scales of the cone and one of the seeds.

Does the bark of evergreen trees differ?

Which holds the snow the longer, the pines or the spruces?

What is the difference in shape between the pines that grow in the forest and those that grow in the field?

Why have so many of the lower branches of the pines in the forest died?

In some places the evergreens do not stand erect. What has caused them to bend over?

5

Did you ever make a watch chain out of pitch-pine leaves? Pull out two leaves from a cluster. Bend the third leaf double and tuck its outer end under the sheath at its base. Then you have a link. Why can you not make a chain from the leaves of a white pine?

COLORS.

Notice the colors which you see on your way to school. Does the snow ever look purple? Where?

How do the tree trunks differ in color?

How many colors do you find on a single trunk?

What colors do you see in the winter sunset?

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VOL. III. CORNELL UNIVERSITY, ITHACA, N. Y. NO. 1.

WINTER PRUNING.

It stormed all day,—first snow, then sleet, and then a downpour of rain. At nightfall it grew colder. The wind blew fiercely. The twigs and branches fell on the white crust which covered the earth. Nature was pruning the trees.

Pruned by the storm.

Have you ever seen your father go into the orchard and prune his trees? Why did he do it? Compare the work done by nature and that which your father does. Which seems to be the more careful pruner?

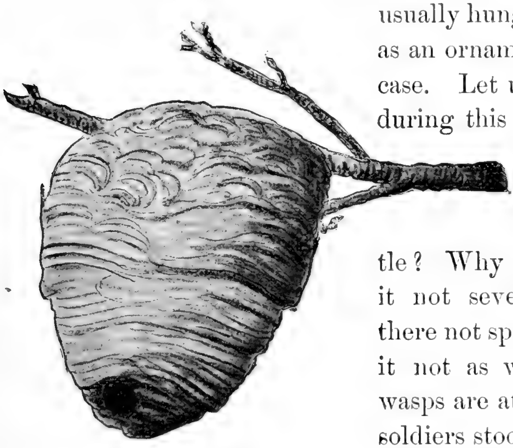
Let us try a little experiment. It will please Uncle John. He always wants his boys and girls to find out things for themselves. Select a branch of lilac or some other shrub. Mark it so that you will always know it. Count

the buds on the branch. Watch them through the spring and summer. Note the number that become branches. You will then know that nature prunes the trees.

If you think a minute, you will see that pruning is necessary in the plant world. Suppose that a branch has thirty buds, and every bud should produce thirty branches, each of which in turn should produce thirty more, do you think there would be any room left in the world for boys and girls? Would a tree be able to hold so many branches?

A CASTLE MADE OF PAPER.

Probably in most schoolrooms in the State there is a hornet's nest which some boy or girl has brought to show the teacher. It is usually hung up on the wall or used as an ornament on top of the bookcase. Let us take it down some day during this month and learn something about it.



The paper castle.

Do you think that the nest can be called a castle? Why not? Look inside. Is it not several stories high? Are there not spacious galleries in it? Is it not as well guarded when the wasps are at home as if an army of soldiers stood outside?

Let us see how this castle is built. You have heard that wasps were the first paper makers. In the early summer you will see them around wood that has been worn by the weather. They take off loose fibres and by means of their mouth-parts work them into pulp. Do you think the rain can get through this paper? Find out whether it is waterproof.

Some of the nests made by Vespa, as the hornets or yellow-jackets are called, are very large. Do you think a wasp could make one

alone? No, these are social wasps; that is, a great many live together. There are males, females and workers. Some day we shall tell you how the wasps form their colony, but for this lesson we want you to study the nest.

Notice the envelope which covers the cells. How many layers of paper are there in it? We might call each layer a clapboard.

Can you see any difference in the direction of the outside layers on top of the nest and those which are below?

How many stories high is the nest?

Note the difference in the size of the stories. Where do you find the smallest?

Count the rooms or cells in each.

You know, of course, that an egg is placed in each cell. When the larvæ, or young wasps are hatched, they still live in the cells.

How do they manage to keep in them? You see the nest is really turned upside down. Their little heads must hang where the worker wasps can feed them easily. I wonder whether you can tell me why the young wasps do not fall out?

The workers chew all the food which they give the little ones. When in summer you see hornets about your flower beds or feeding on other insects, it may be that they are preparing breakfast for the young. Notice the flowers which they visit.

DESERTED BIRDS' NESTS.

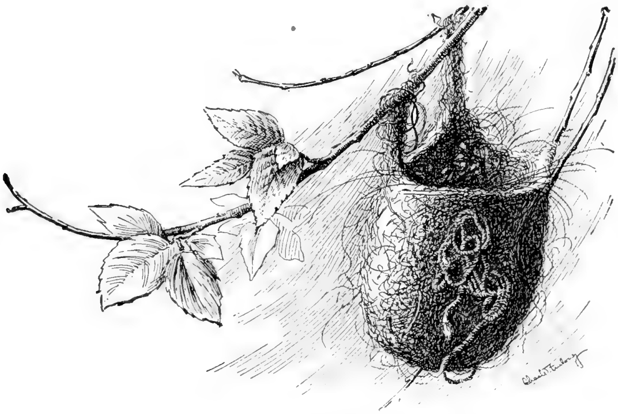
The vireo's nest.

There is a wagon trail which I like to follow; it is always a pleasant walk. There is no footpath, so I do not think many people pass that way. Perhaps this is why so many little wild creatures of the field and wood like to live there. I do not know any other

place where the birds sing so sweetly, where the wild flowers grow so thick and where the insects are so merry.

By the side of this road I found the little vireo's nest which you see in the picture. It was about five feet from the ground, and hung near the end of a long branch. It was interesting to find out what it was made of,—grasses, strips of bark, hair, pine needles plant fibres and bits of paper. The outside was decorated with spiders' webs and lichens. The pieces of paper were dropped along the way, I think, by the leader in a cross-country run. Even the little vireos have an interest in the out door sports of the college men.

One of the most interesting bird homes is the oriole's nest. Uncle John will like to know whether you find one. The young orioles must have happy times in their cradle which hangs between the earth and the sky.



The hanging nest of the oriole. A cord is woven into the design.

This is the best time of year to hunt for birds' nests. It is hard to find them in the spring and summer. The parent birds intend it shall be. If you succeed in getting a nest, take it into the schoolroom so that the other members of your club can study it with you.

Suggestions.

Where you find the nest. Its size and shape.

Was it built on a horizontal crotch of the branch, or on an upright crotch?

5

How was it fastened to the branch?

Notice the materials of which it is made.

In the oriole's nest you will see that there is a difference in the way in which the upper and lower parts are made. What is it?

How deep is the oriole's nest which you find? Compare the material on the outside with that on the inside.

How is the nest fastened to the twigs?

Where does a cat bird build its nest?

ALICE G. McCLOSKEY.

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VOL. III. CORNELL UNIVERSITY, ITHACA, N. Y. NO. 2.

ROBIN !

The drifts along the fences are settling. The brooks are brimming full. The open fields are bare. A warm knoll here and there is tinged with green. A smell of earth is in the air. A shadow darts through the apple tree : it is the robin !

Robin ! You and I were lovers when yet my years were few. We roamed the fields and hills together. We explored the brook that ran up into the great dark woods and away over the edge of the world. We knew the old squirrel who lived in the maple tree. We heard the first frog peep. We knew the minnows that lay under the mossy log. We knew how the cowslips bloomed in the lushy swale. We heard the first soft roll of thunder in the liquid April sky.

Robin ! The fields are yonder ! You are my better self. I care not for the birds of paradise ; for whether here or there, I shall listen for your carol in the apple tree. L. H. B.

WELCOME THE BIRDS.

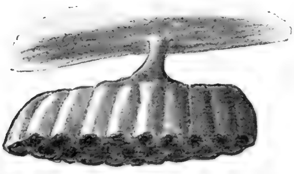
" They'll come again to the apple tree —
Robin and all the rest,
When the orchard branches are fair to see
In the snow of blossoms dressed,
And the prettiest thing in the world will be
The building of the nest."

How can you watch the birds build their nests? Coax them to come and live near you. You can do it, if you are patient. The first thing to do is to build a bird house. Leaflet No. 10, "The Birds and I," gives a number of suggestions for making bird houses. You can learn more by bringing the birds to you than you can by going out to find them.

Leave materials for the nests where the birds can get them. Provide food. They like crumbs, bones in which there is some marrow, and pieces of suet which can be fastened to a tree near the bird house. Be sure that there is plenty of water where they can find it.

Do what you can to protect the birds from their enemies. They probably fear cats more than any other. If pussy is well fed she may leave the birds alone. D. Lange, in a book entitled "Our Native Birds," gives a good suggestion for keeping cats out of trees. He says: "Surround the tree about five feet from the ground, or just below the branches, with several coils of barbed wire about two feet wide."

POLISTES, THE PAPER MAKER.



Home of Polistes, the paper maker.

Last month we spoke of Vespa wasps that make homes of paper. You learned that they bite off pieces of weather-worn wood with their jaws and chew it until it is made into pulp. Were you interested in these social wasps? If so, you may like to hear about another member of the same family.

Hiding in some crevice about your house or the school building there is probably a wasp which naturalists call Po-lis'-tes. She has been there ever since the cold weather came. In the spring you may see her tearing off pieces of wood from some unpainted building or weather-worn fence. Let us see what she is going to do.

This wasp is the founder of a colony. The first thing she does is to select a place for her home. Then she makes a few cells — only a few for she has no help. When you find a nest like the one in

the picture, you will see how the comb is fastened to the roof or a tree or to the under side of a stone.

As soon as the cells are completed the mother lays an egg in each. From these eggs larvæ are hatched. They are fed by the mother until they become pupæ. The cells are sealed over while the wasps are in the papa state. They have to break open the seals before they can come out.

All of the first brood are workers. As soon as they are hatched the mother has nothing to do but to provide eggs. They clean out the cells in which they passed their early days ; they make additions to the nests ; they take care of the young. Do you remember how the Vespa workers prepared food for the larvæ in their colony and what they fed them ? The young Polistes are cared for in the same way.

You may see the workers flying about in your garden this summer, getting the sweets from the flowers that you have planted. You will know why they are so busy through the long sunny days. You will think of the hungry little wasps waiting for their dinner. You will wonder whether they put their heads out of the cells when the workers feed them.

Nest of Polistes.

Compare the nest of Polistes with that of Vespa.

In what ways do they differ ?

Where did you find the nest ?

How was it held in place ?

How many cells are there in it ?

Notice the pieces of the seals which still remain on the nest. Tell us whether they are made of the same material as the cells. Of what use are the seals ?

A BUTTERFLY IN WINTER.

When a warm February or March day comes you may see one of the first messengers of spring — the Mourning-cloak butterfly. It has been in some dark corner all winter, probably in your cellar, and seems glad to come out into the warm soft air. This butterfly

has a dark purple mantle with a cream-colored border. The wood-cutter is most likely to see it because it feeds on the sap of trees which have just been cut down. Scientists call it Vanessa (or Euvanessa) antiopa.

MARCH.

LUCY LARCOM.

March! March! March! They are coming
  In troops to the tune of the wind:
Red-headed woodpeckers drumming,
  Gold-crested thrushes behind;
Sparrows in brown jackets hopping
  Past every gateway and door;
Finches with crimson caps stopping
  Just where they stopped years before.

March! March! March! They are slipping
  Into their places at last:
Little white lily-buds, dripping
  Under the showers that fall fast;
Buttercups, violets, roses;
  Snowdrop and bluebell and pink;
Throng upon throng of sweet posies,
  Bending the dewdrops to drink.

March! March! March! They will hurry
  Forth at the wild bugle-sound;
Blossoms and birds in a flurry,
  Fluttering all over the ground.
Hang out your flags, birch and willow!
  Shake out your red tassels, larch!
Up, blades of grass, from your pillow!
  Hear who is calling you — March!

ALICE G. McCLOSKEY.

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VOL. III. CORNELL UNIVERSITY, ITHACA, N. Y. NO. 3.

SOMETHING FOR YOUNG FARMERS.

If our Junior Naturalists were to visit Bell-Wether, Uncle John's farm, they would be surprised to find how many different plants grow there. Uncle John loves these plants,—everyone of them; that is why they are so thrifty. He prepared the soil carefully before he planted them. He gave to each plant the place in which it would grow best. If a tree were injured, it received special care until it grew stronger. Even some wayward growers were encouraged, for Uncle John knows that the straightest and handsomest trees do not always bear the best fruit.

In walking through the orchard at Bell-Wether you would find that the trees look very much alike. You would not think that any one could tell them apart. Uncle John can. He knows every tree. If some of them were to change places in the night, I believe he would find out the next morning which ones had been trying to play a trick on him. He knows them well because they are his own. He planted them. He is responsible for their welfare. They have a place in his heart.

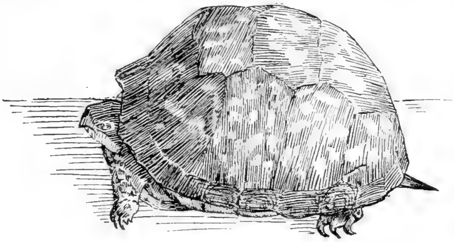
We want ever Junior Naturalist to have a farm this spring. It may not be so large as Bell-Wether, but you will enjoy it if it is your own. If you have no garden in which to grow plants, make a window garden. Uncle John will tell you in his next letter how to have a successful farm. You will also find that Leaflet No. 4, "A Children's Garden," will help you.

Whether your farm be large or small grow a geranium. Some

one has said that we should love this plant best of all because it has given more pleasure than any other. The plant is sometimes called crane's-bill. Find out from the plant why it was so named. The seed pods will tell you.

TURTLES.

Since you are naturalists, you ought to learn something about turtles. Do you know where they live? What they eat? Where they spend the winter? How they protect themselves from their enemies? How early in the spring can we find them? Can you tell a land turtle? A mud turtle? A water turtle?

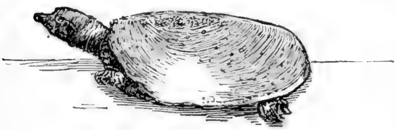


Land or box turtle.

Land turtles are awkward creatures. They are usually good-natured, however. You see they do not have to protect themselves by biting at everyone and everything. If an enemy come near, the land turtle gets inside his shell. It is a very perfect armor. These turtles are called box turtles. Why? What clumsy feet they have! They remind one of an elephant's. Notice their claws. Why do you think they need such large feet and claws?

One of the mud or snapping turtles.

Young naturalists know some of the mud turtles best,— snapping turtles and painted turtles. Can a snapping turtle shut himself up in his shell so that he is completely covered? Do not ask any one to answer this question for you. Find out for yourself. There may be some reason why a snapping turtle is not so good-natured as a box turtle.



The water turtle.

If you have a water turtle in your aquariam, the first thing that you will see is that he is very flat. You will then find out that his armor differs from that of the land turtle. In what way? You will notice that he has a long nose. If you watch closely you will learn why it is a good thing for a water turtle to have a long nose. His feet differ from a land turtle's. How?

Try to keep some turtles in the school room. Arrange quarters for them so that they can be in the water or on a dry surface. Feed them pieces of raw meat.

PLANT SOCIETIES.

You know that different plants grow in different places. You go to the open field for daisies, to the woods for mosses, to the swamp for Jack-in-the-pulpit. You know, too, that certain plants live together; and these plants form "Societies" as boys and girls do when they agree to live together in a Junior Naturalist Club. You do not expect to find daisies growing alone in the field. Moss does not cover the entire floor of the forest; Jack-in-the-pulpit is not sole proprietor of the swampy land.

Let us begin to think about the plants that live together. Watch them when they first appear. Note the number and kind in each place or society. What changes take place in the society during the summer? Do new plants come in as the days go by?

How pretty some plant colonies are! Down in the valley, saxifrage and ferns grow on the side of a bank. On sunny afternoons shadows from the tall pines above lie across the little colony. There are other plants there besides those bearing the white blossoms and the green fronds. You will always find, however, that in every plant society one or two plants seem to have right of way.

The prettiest colonies are not always the most interesting.

> "I like the plants which you call weeds,—
>   Sedge, hardhack, mullein, yarrow,—
> That knit their roots and sift their seeds
> Where any grassy wheel-track leads
>   Through country by-ways narrow.'

Find a weedy bit of land in some neglected part of your garden. There may be many different plants living in a small space. Who will find the largest number in one patch or colony? Who will be able to send the best history of a colony to Uncle John next September?

The plant societies will soon appear. Every bit of plant-covered land is a society. The field is one; the bank of the stream is another; the roadside is still another. The lawn is a plant society; the chief occupant is grass, but there are dandelions and plantains and perhaps docks. Notice the weedy and brushy societies in the fence corners. What plants live together in a society? Do not try to study more than one society this year. Dry a specimen of each plant that you will find in it. Add to your collection as new ones appear during the summer. You will be surprised to find how many specimens you will have when the season closes.

WHAT SHALL WE FIND IN A STILL POOL FOR OUR AQUARIUM.

Materials for an excursion.— A good sized tin pail. A scoop net. A knife.

What you may find.— 1. Toad's eggs. They will look like strings of beads wound about water plants. Teachers' Leaflet No. 9 will help you in finding them.

2. Eggs of wood frog. The small dark eggs quite close together are surrounded by a mass of jelly-like substance.

3. The eggs of Amblystoma, the Salamander. They resemble those of the wood frog, but they are not so close together. Amblystoma is black with yellow spots on each side of his back.

4. The eggs of Diemictylus, another Salamander. You will find these later in the season. They are attached singly to water plants. Who will find some? His body is green above and lemon-yellow underneath. On either side there is a row of scarlet spots each surrounded by a black ring. These Salamanders are described in the Monthly of last December.

Listen for the "spring peepers."—What is a "spring peeper?" No wonder this question is so often asked. It is no easy matter to see the little fellow. We hear the first faint note of his song in early spring. Thoreau says: "If you do not listen carefully for its first note you will probably not hear it; and not having heard that, your ears become used to the sound, so that you will hardly notice it at last, however loud and universal." If we follow the sound, wading into the pool whence it comes, we may find the little chap. What does he look like? It is a small frog, scarcely an inch long. He may be in the water; he may be clinging to the stem of the plant. These little frogs stay about the pond in spring and early summer. Later they become "tree toads." If you find one notice the pads on his feet. These are sticky and help him in climbing.

The Aquarium.—Teachers' Leaflet No. 11 gives directions for making an aquarium. If yoù follow the directions I think you will be successful in making one. *Keep the water pure. Do not have too many creatures in it at one time. Give them plenty of food.*

ALICE G. McCLOSKEY.

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VOL. III. CORNELL UNIVERSITY, ITHACA, N. Y. NO. 4.

NATURE IN SUMMER.

The school year is nearly over. Boys and girls will soon have long, happy, idle days. They may go where they will, seeking new acquaintances in the fields, in the woods, and along the roadside. If there were space in the leaflet, we could mention hundreds of living things that would interest our young naturalists. Since we can only speak of two or three, we shall select those which we do not want you to overlook. Uncle John will be glad to learn next September that you have found out something about them during the summer.

FIELD ACQUAINTANGES.

Crows.

It was thinking of "Old Pete" that made me decide to recommend crows as good field acquaintances. No one could think of Pete and not wish that all Junior Naturalists might have known him. He was certainly a wise old crow. Everyone in the village admitted this. Everyone liked him, too, yet he played mischievous tricks on his best friends; he stole whatever pleased him from among their treasures; he jeered at them whenever he felt like it in a most aggravating way.

One trick of Pete's was very annoying to many a housewife. Some of the women in the village were very industrious and often

had their week's washing hung out shortly after sunrise. No sooner were the clothes on the line than Pete was on the line too. Such a bold, saucy looking Pete! Silently he worked till every clothespin was removed, and every clean garment lay on the ground. Then with the utmost glee, he would mount a post and boisterously call the housewife to see what he had done.

Sometimes this bold crow was captured on Monday morning and deprived of his liberty for the day. This was a severe trial to the clever old fellow. It was not pleasant to be shut up in a cage. He would rather walk down to the grocery store, a daily custom, where he often introduced an emphatic "Caw" into the political discussions of the men.

Pete has been dead many years. If he were still alive would you not go a long distance to see him? There are other members of his family living among you. Many of them are as wise and interesting as he. Why not become acquainted with some of them this year? Perhaps the following suggestions will help you:

1. There is nothing black in nature, so the artist tells us. Our "black" cat is a deep violet color. Blackberries are not black, are they? What do you say about crows? Is there any color in their handsome, glossy coats?

2. Crows eat corn. We all know this. Do they also eat insects which injure the farm crops? Here is a good subject for young investigators.

3. Crows have a language. The patient student of nature can learn it. Note the different cries with which they express joy, fear and anger.

4. Have you ever seen a sentinel on watch while the other crows are feeding?

5. Where do these birds build their nests? Are the nests large or small? How many eggs have you ever found in one?

6. A tame crow is an interesting pet. If you have one tell us about him.

ACQUAINTANCES OF THE WOODS.

SQUIRRELS.

The hot sun of a May or June afternoon sends you into the cool, quiet woods. You may not want to form any new acquaintances. It is pleasant to be lazy in the woods; to listen to the song of the wood birds, to hear the hammering of the woodpecker, and to look up at the sky through the tree tops.

Suddenly a little yellowish gray creature appears. There is a rusty color along the middle of his back and tail. You look into his inquisitive bright eyes. You know it is the red squirrel. He does not fear you. "The sylvan folk seem to know when you are on a peaceful mission and are less afraid than usual." Can you refuse to make the acquaintance of the merry little fellow? Can you resist taking an interest in his cheerfulness, his contentment, his cleverness, his love of mischief; and I must add, his conceited little ways? Let him come into your heart. You will not find any of the wood-folk more companionable than he. Keep up the acquaintance all through the year How much will you learn of his history in that time?

Red Squirrel.

1. Does the red squirrel hibernate; that is, does he go into winter quarters? Have you ever seen him out on cold days?

2. What does he eat? Does he store up food when there is plenty?

Have you ever seen him gathering cones? What does he do with them?

3. Watch him as he springs from bough to bough. Why is he so fearless? Have you ever seen one fall while trying to leap from one tree to another?

4. Notice how active the red squirrel is on moonlight nights. Does he chatter then?

5. Do these squirrels make nests for their young? If, so where?

*   *   *

It may be that a little chipmunk will come near you to find out what is going on. He will demand as much attention as the red squirrel. What a nervous little creature he is! How he chatters and scolds and shakes his thin little tail! How cautiously he moves from place to place! His life seems to be one of constant fear; fear of what, I wonder?

Chipmunk.

Notice the stripes on the chipmunk's back. How many are there? Are they all the same color?

Why is he called a ground squirrel? Where does he spend his time? Do you ever see him in a tree?

A chipmunk is very industrious. Look at his cheek pouches. Are they not nearly always well filled? Where does he store his food? What does he like to eat?

Do you think that the little ground squirrel always knows where he puts his treasures? It may be that he sometimes plants a tree. Who knows? This might happen if he should forget where he hides his acorns or other seeds.

Who has seen a chipmunk in the woods in cold weather? Next

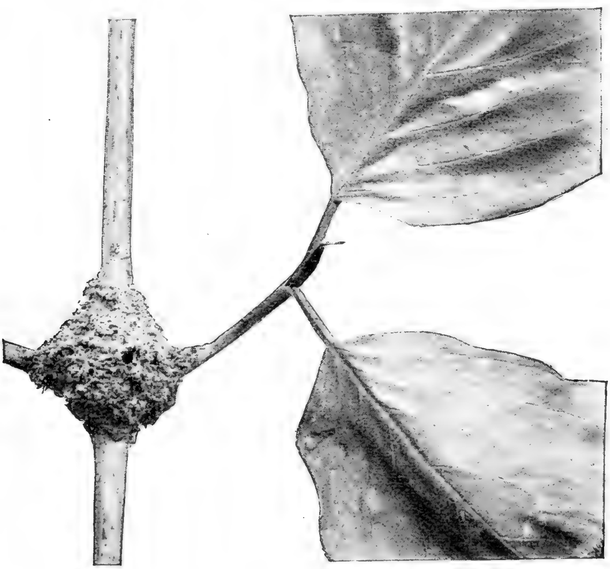
year our boys and girls will be so much interested in him that they will *know* where he is, winter and summer.

Have you ever watched chipmunks at play? Tell us about their games. Do they live alone or are they social little fellows?

ROADSIDE ACQUAINTANCES.

Ants and Aphids.

No matter how hot the sun, nor how dusty the way, we enjoy a country roadside in summer. It is overflowing with interest. There is so much going on and it all seems so important that even the



A house built by ants to protect the plant-lice.

naturalist hesitates to ask a question. Let him sit quietly for awhile, content to be a "looker on" in the busy world. The wayside folk will not stop their life work because he has come among them. He can learn much by watching.

Perhaps no creatures are more indifferent to the world outside their own than ants. They have no idle moments. There are so many interesting features of their daily life that it is hard to suggest one for special study. I think, however, that our boys and girls will like best to learn about their cows and how they take care of them.

Along any roadside where plants are growing you will find aphids or plant-lice. These little insects are useful to ants in much the way that cows are to people. They provide food for them.

Vagabond-gall on the cottonwood.

Have you ever noticed a sticky, shiny substance on the leaves of plants? Sometimes it drops from the trees on the paved streets. This is honey-dew which ants like so well and which aphids give them. There are little tubes on the backs of the aphids. You can see them by looking through a microscope. They are called honey tubes, as it was supposed that the honey-dew came from them; but this is not so.

Ants take very good care of the aphids. In the picture you will see a "cow shed" which one kind of ant builds for them. It is on a twig of dog wood. When I found it the ants were crowding in at the little door which you see in front. I suppose they were hungry. Do the ants that build these "cow sheds" live in many places in New York State? We hope to find out from our Junior Naturalists.

Professor Forbes tells us about a little aphid that feeds on the roots of corn. In winter small brown ants take care of the eggs of this aphid. They keep them in their own nest. If the nest is disturbed, they will carry the eggs to a place of safety.

You can all observe ants protect aphids from their enemies. Put your finger on a twig or leaf among the aphids and see how the ants will attack it. Find out the enemies of the aphids. Is the "lady bug" one? You will often see it among them.

While studying aphids I think you should learn that many are injurious to plants. They cause that ugly gall, called the vagabond-gall, which we find on the cottonwood tree. You will see how it looks in the picture. You will also see a smaller gall on one of the leaves. This was made by another kind of aphid. The first specimen of the vagabond-gall sent to us by a Junior Naturalist came from School No. 1 in Elmira. The boys and girls there were much interested in it.

ALICE G. McCLOSKEY.

CORNELL READING-COURSE FOR FARMERS' WIVES.

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READING-LESSON SUPPLEMENT NO. 1.

For Farmers' Wives.

JANUARY, 1901.

BY MARTHA VAN RENSSELAER.

SAVING STEPS.

The reception accorded to the Cornell Reading-Lessons by the farmers of the State has been most cheering to those who have had charge of the work. The general hearty response and the many appreciative letters received, suggested that a course for women along similar lines would be helpful. The beginning of an enterprise of this kind is always the most difficult part. In order to ascertain the attitude of the farmers' wives of the State towards such a course, the following circular letter written by L. H. Bailey and J. W. Spencer was sent out last year:

"To the Farmer's Wife:

"Ever since the inauguration of our Farmers' Reading-Course, it has been our plan to make it a partnership course between you and your husband. In all the vocations of life, there are none in which success depends so much upon the wife as in farming, and we never think of an unmarried farmer. Of a hundred widows each with a family of children and a farm, we are sure a larger percentage will make a success in the single-handed struggle than would the same number of widowers in the same conditions. Since you are such an important factor, we do not intend that you shall be left out of our plans for helping the farmer.

"In doing this, we must ask you to help us to help you. Every public speaker will tell you of the discouragements in addressing an audience when his words awaken no response. If the hearers cannot agree with him, he would much prefer that they talk back than to go away ignoring what he has said. In our case, we want each one of you to talk back, even though you feel called upon to tell us we are wrong. We mean this in all seriousness, and hope that you will take us at our word.

"The question now is, which problem in housekeeping shall we first take up for consideration? There are so many questions that it is hard to decide where to begin. To open the acquaintance, we must choose a topic that is easy and common to the experience of all. Let us make it *Steps — The Housewife's Steps.* How many do you think you take in preparing a meal and washing the dishes? Have you any idea how far you travel? Count the number to-morrow when preparing breakfast. If you cannot count the whole number, count as long as you can and guess at the rest. Then tell us how many miles you travel each day, considering that twenty-six hundred steps make a mile. As you probably prepare about a thousand meals each year, tell us how many miles of meal travel you make. I know of some women who, I am sure, have taken steps enough to circumnavigate the globe and are not aware that they have ever done anything remarkable either. This is just the point to which we wish to arouse your attention — that you are doing much more than you are aware of — and next we want to consider whether it has all been unavoidable. If we find that, in many instances, two steps could be made to do the work of three, there will follow a saving of thirty-three per cent — a saving which any manufacturer or merchant would seize with alacrity. I am sure you need such a saving as much as they.

"I wish you would write us on this topic, for it will enable us to form an idea as to whether it is a profitable one for us to consider. However, lest you may be too tired by taking too many of these steps and cannot write, I hope you will give us your address on the enclosed card, put a one-cent stamp on the corner and mail it. By that we will know that you wish to hear what the others have to say.

"I think you understand that there is no cost to you in all that we may do for you, as all expenses are paid by an appropriation made by the State for University Extension of Agriculture."

Suggestions from Our Friends.

In response to this, many letters were received containing valuable suggestions, and showing interest in the work of the women's department. We have taken the liberty to print extracts from a

few of these, believing that the experience of the writers of these letters will be of value to others:

Systematic mother brings up her daughter to save steps.—"The extra steps that we are obliged to take make the spirit weak as well as the flesh. I find it hard to arrange my work so as to reduce the steps. There are four little ones and one big one that are constantly calling me to step to their time, making it seem like trying to march to two-steps and waltzes. I was brought up by a systematic mother who had by long, hard experience learned to save the steps, and constantly enjoined her daughters to do the same, and make their heads save their heels. I have tried that for fifteen years and find it works well."

More work accomplished by forethought and when mind and body are at rest.—"When I awaken in the morning I do not rise immediately, but I plan the work of the day, and study to see how I may save steps and accomplish as much work. I find that if I go about my work thoughtlessly, I travel over the same ground several times when it is not necessary. Before I learned to do this I would get up suddenly after awakening, and at once feel a sense of hurry which soon became worry, and before the forenoon was over I was exhausted in my efforts to see how fast I could work. Now, when I feel myself getting anxious, I try to relax mind and body, and the work goes more smoothly and I accomplish more."

Transform drudgery into work that is joyful by looking on the bright side.—"A few steps more or less don't matter much if the breakfast is a success. To enjoy a car ride I must not confine my attention counting the railroad crossings. I shall miss the flashlight glimpes of hill and vale, and the long stretches of fertile fields. Now, it seems to me the one thing that all workers need — perhaps farmers more than town's people — is to keep above the thought of drudgery — to look beyond the toiling to the result, and so transform drudgery, which no one enjoys, into work; and when work becomes spontaneous, it is no longer under the law of necessity, but is joyful and free from strain and pain. I might tell you how circumstances made it necessary for me to leave the school room and come back to the old homestead; how later on the depression in

farm lands prolonged my stay; but sufficient to say I am here, and have come to enjoy the work that was at first so distasteful to me."

Men not indifferent but often thoughtless.— "I am a farmer's wife, but not one of your drudging kind. I think any woman will agree that we can work from morn till eve, if we are so inclined. I plan to do just so much before dinner, and often have to add a little more steam, but my house is in order and dinner on time, and after the dishes are out of the way, I tidy myself up, and have the afternoon for rest. I am fortunate in having a kind husband, but I think the men are often censured for indifference, when it is only thoughtlessness. Just remind them that you haven't any water to get dinner with, and I know your pail will be filled; and the wood-box also. Don't do it yourself."

Bad habits formed in good health not easily corrected.— "We get into bad habits of making needless trips from room to room while in good health, when we feel it is not particularly worth while to save steps. These habits cost us dear, however, when at last infirmities come upon us, as they are almost sure to do sooner or later."

Wants boys and girls to become farmers and farmers' wives.— "I have the care of thirty little girls and boys, orphans. My heart's desire for them is that they shall become, eventually, farmers and farmers' wives. May I venture to suggest that you will hit the nail squarely on the head if you teach American farmers' wives how to furnish their tables? Alas, these days of plenty and the overwhelming circulation of cook-books are as destructive to health and happiness as the calamity of poverty. If a farmer's wife is a slave to the palate, she is a destroyer rather than a defender of good health — unwittingly, of course."

Necessary to rest the body by feeding the mind.— "As a class farmers' wives are expected to do more work than any other housekeepers. As a rule we do our own washing, ironing, taking care of the milk, meat, chickens, which women of other callings do not do. We do our own sewing, making over an infinite number of old clothes to save the expense of new ones, as the cash, when the hired help is paid, is in the negative. If you can make us understand

that it is just as necessary to rest the body by using the mind a little to read — if the floor doesn't get scrubbed so often — you will do much good. I think I stopped to read your letter, with a table full of dishes to wash, and a boy down with the measles."

Stop and think how many things are needed before traveling to and from the cellar.— "When one is clearing away and washing the dishes from one meal decide what is to be had for the next meal, and if there is anything in the cellar or storeroom that will require time for preparation, bring it back with you when you go there with the remains of the last meal. Before beginning to get a meal, stop and think how many things one will need from the cellar, and bring as many as possible at a time, and not climb these 12 or 15 stairs as many times as there are articles needed."

"I save steps by putting refuse all together, and one trip empties it, without going to the pail with each separate contribution. As I go out to empty something, I bring back some wood, if in summer; if in winter, I take the coal pail, so do not return empty handed. I keep a small crock containing brine in my cupboard that will hold about as much salt meat as I use in a week; that saves going down cellar every time the meat is wanted. I pack up my dishes as compact as may be to take from the table, but carry them on a tray instead of putting them in the dish-pan to carry, for they would have to be taken out upon reaching the kitchen, as I do not wash all my dishes together. It is well to have one's meals planned for the day, and then should a friend happen in to dine, it does not make extra work, nor throw one into a fever of excitement in wondering what will be had for dinner. Our friends do not want to make us extra work, and I enjoy having someone drop in about meal time and take just what I have prepared for the family."

Think more of the comfort of the family than to outdo the neighbors.— "I think that many of the unnecessary steps I take are caused by forgetfulness. Another cause of extra steps is putting up things that someone else has left out of place. I find a great saving in having the stove near the sink and cupboards. A cupboard half way down the cellar stairs to put provisions in is better

than going down the full length of the stairs. Two or three shelves on the side, that can be reached by just opening the door, will hold many things very conveniently. I wish housekeepers could be made to think more of the comforts and pleasures of their families, and less of trying to outdo someone else, and keep in the latest fashion. When we visit a neighbor and she gives us about three times as many kinds of food as we need, what is there left to do when she visits us? Plain living and high thinking would put money in many a farmer's pocket, and make possible some extra pleasures."

Eliminate pie and cake.—"Most families would no doubt be more healthy and therefore more comfortable, with pie and cake nearly eliminated from their bill of fare, and more fruit and vegetables used instead. In studying to determine what will be a most healthful diet for the family, we can also learn to prepare those things which will save steps and economize time."

More than a washboard, tub, churn and pans needed.—"In the general farm houses there is little thought given of the steps the housewife and mother take, as farmers too often think it is not necessary for her to have improved kitchen furnishings. He frequently thinks if she has a washboard, a tub, a churn, a few pans and pails and a garden hoe, that is enough — while he has all the late improvements to make his work easy and save his steps. I tried to count my steps while getting breakfast this morning. I traveled about two miles while preparing the meal, doing the dishes, preparing chicken feed, pig feed and waiting on the children — for I have five small ones."

Scientific knowledge needed.—"What house-keeping needs is just what farming has needed: the application of thorough scientific knowledge and methods. To this end there must be thoroughly trained women who are perfectly acquainted with the details of house-keeping, and who are ingenious in the application of their knowledge to these conditions."

Appreciation compensates for extra labor.—"My kitchen is off from the main part of the house about seven feet, and there are two steps for me to go up and down. Our dining-room is in the main house. I often wondered just how many times I went back and

forth in a day. One morning I counted 20 times. One way that housewives may save many steps is to have one of those kitchen cabinets that hold all the flour, meal, spices, etc. Dare I say that the men can help more than anyone else to save steps? They can lighten our work by encouraging and praising us. If one of those lords of creation comes in and doesn't even say one word, but smiles, picks up the water bucket, and brings in a lot of wood, or takes up the ashes, how pleased we are! But if he comes in and takes the last drop of water out of the bucket that our poor tired hands have drawn and brought in, that doesn't save steps. Still we perhaps would be too tired to notice this, if he would only not say, 'I never come into this house but that the water bucket is dry!' If in taking the water, he would say, 'How nice of you to have water right here for me!' I really believe we would feel compensated for our extra labor."

Wealth to the farmer to save his wife's steps.— "I think it very considerate to wish an estimate of the housewife's steps taken in the interests of her husband's prosperity on the farm, or rather, of the husband's and wife's prosperity. I deem it wealth to the farmer whose wife's steps are made few, and everything about the house as convenient as possible, securing her health in order that she may be the helpmeet of her husband."

Build the sink and tables high so as to avoid stooping.— "There should be hooks near the sink for the large dish pan, the handled dish cloth and a shelf of the height of the sink, which should be so high as to reach nearly to the house-keeper's waist so as to save her the painful stooping and also protect her from the slopping of water. A high stool should stand in every kitchen upon which the mistress can sit while compounding bread, cake and other foods, washing and wiping dishes and cleaning vegetables."

Suggestions by the Editor.

Dog on the churn works mechanically.— The dog on the churn keeps his feet continually moving, without making any headway. The floor beneath moves under him, yet he is at the same point in relation to other objects as when he started. When the dog is

released he does not know but that he has traveled a mile of space, nor is he troubled over to-morrow's churning. He is simply, dog fashion, pleased in the present moment's release. He has churned the butter, but he does not know it.

Dull routine may be drudgery but intelligent interest adds pleasure.— A woman spends 365 days getting meals and doing the other work necessary in her home, only to realize that the members of her household are still as hungry as they have been, and that they will be hungry every day of the next year. Her work has become routine, yet she is conscious that unless this same round of labor and each little duty had been carefully performed, there had been a serious interruption to the success and happiness of that home. The dog's work is mechanical; hers is intelligent. She finds a pleasure in her effort to conserve time and strength. The pleasure to her family and herself is in large degree her reward.

Forty-eight hours of work crowded into twenty-four.— One thing is certain, when a woman has crowded forty-eight hours of work into twenty-four, and still finds the stove is not polished, the windows are not washed nor the sewing touched, saying nothing of her inability to find time to read or to return calls, she is required to study what she can best leave undone, and how to do the things she must do with least expenditure of time and strength.

Catch a glimpse of the sunset.— She knows her work will be too much like that of the dog on the churn unless she catch a glimpse of the sunset now and then, chat with a friend or enjoy a favorite author. If in the morning she finds her kindling ready, or the fire laid, her table ready set, the potatoes peeled, and in place of going to the well, priming the pump and wielding the handle to get enough water to start her breakfast, she can turn a faucet in her kitchen and get all the water needed, her day is started quite easily. Perhaps the water is brought to the barn by a windmill or by gravity system, why not into the house?

Have a tile drain for waste liquid.— Does she have to carry all the waste water to an outside door, down a flight of steps and to a safe distance from the house where it is thrown on the ground? Could there not be a sink or hopper constructed in the kitchen with

trap connection to a tile train and cesspool and thus save many steps and much hard lifting? Glazed tile, though more expensive, is safer on account of the joints being cemented which prevents the contamination of well water. How much would it cost? Tile can be had for four cents a foot, the drain will be laid from ten to twenty-five feet from the house, depending upon the situation of the well if there be one.

The expense is slight—

Twenty-five feet of vitrified tile..................	$4 00
A sink.....................................	1 25
Pipe and trap connection........................	1 00

The drain will probably be dug by the farmer or his help when other work is not pressing. The actual cost then will be $6.25 for a permanent means of carrying off the waste water used in the kitchen, or if this water can be utilized in the garden, it may, if there be a gradual incline from the house to the garden, empty itself into a barrel through pipes or a trough laid for the purpose and which may also collect the surplus rain water from the eaves. Fruit and vegetables will flourish by reason of this water supply.

An ice box should be constructed.— Unless ice is brought into the house it is necessary to keep the perishable provisions in the cellar. This necesitates traveling to and from the cellar throughout the entire year, for they must be kept there in winter to avoid freezing. Perhaps the cellar is not conveniently located, nor the stairs easy. With but little expense an ice box can be constructed for use in warm weather. A wooden box lined with oil-cloth, zinc or galvanized iron, having a hinged cover, and with a hole bored in the bottom for the escape of water, has served many a family for a refrigerator. Shelves may be arranged on the sides so that the ice can be put in at the center. These shelves are perforated or arranged in the form of slats to allow a circulation of cool air. The box should be within another with a space between to be filled with some non-conducting material, as charcoal or sawdust, or a lining may be built within the box affording such non-conducting arrangement. The amount of provisions saved in one season by the use of

a refrigerator or an ice box more than pays the expense of one; and many trips to the cellar are saved the housekeeper.

A woman may make money out of her ice harvest.— An ingen-

1.— *Window provision cupboard to save trips to the cellar in cold weather.*

ious housekeeper secured permission to use the pond on the farm as she desired. She had it thoroughly cleaned in warm weather

when the help was not needed in other work. With lumber already on the place she had constructed a small building near the house, and with sawdust drawn from a neighboring mill, the house was prepared for the storing of ice. When the ice was ripe for harvesting a good supply was stored for summer use. The following season she sold ice to her neighbors, thus securing considerable spending money. But there are not ponds on all farms.

A common ice house at the creamery.— At the creamery they have a demand for ice, and there is a running stream. Why may not the patrons unite with the owners of the creamery in damming the stream and securing a large quantity of ice? One large ice house may save the expense of several in a community, and the waste of ice will be much less. In warm weather the patrons in returning from the factory may carry home the ice needed for their own homes. The expense, after the first year, will be slight, and the ice house is there for a term of years.

A window cupboard saves steps.— Many a thrifty housekeeper has found in cold weather that a window box saves her many trips to the cellar or to a room kept cool enough for provisions. A window in a pantry, dining-room or kitchen is made to move easily up and down. A dry goods box the size of the lower sash is fitted into the window from the outside and fastened to the casing. Holes are punctured in the box, or wire netting may form one side for ventilation. When the window is lowered the provisions are kept as cool as the outside air, and near the place where the work is done. Fig. 1 shows such a box as found in one home.

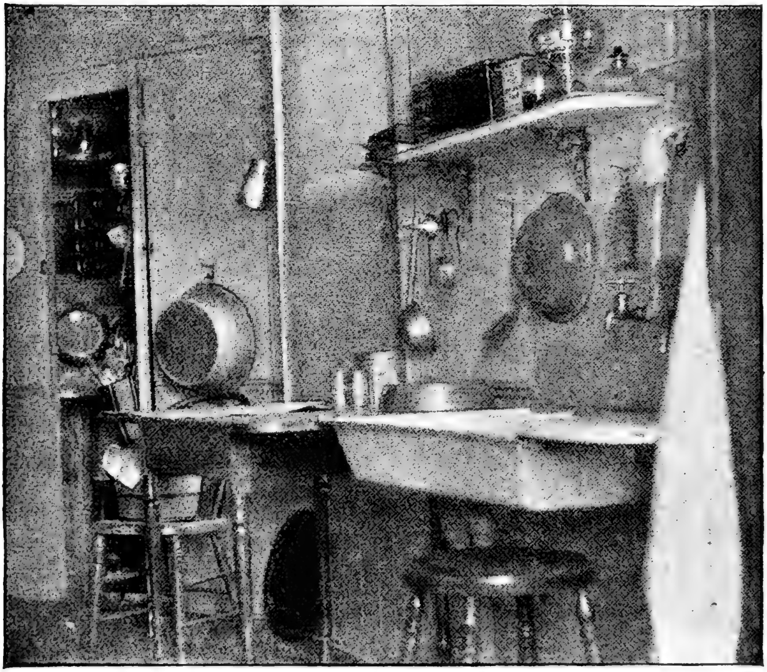
Hints on Kitchen Facilities.

The interior arrangement of houses and the placing of utensils make a great difference in the number of steps to be taken. Articles not often used should be placed in the further corners and give place to those which are constantly in demand. Fig. 2 shows another corner of a kitchen, with various conveniences and everything within easy reach of the stove.

A high stool saves long standing.— Note the high stool under the sink which may be used when vegetables are to be prepared or

dishes washed. The iron dish cloth over the sink saves both time and annoyance in washing pots and kettles.

Use a tray for carrying dishes.—The tray on the floor suggests that the soiled dishes are brought on it from the dining-room to the kitchen to be washed and returned in the same way. The pail at the end of the table is for garbage, and is kept clean and is easily emptied by means of a newspaper placed in the pail each time before it is used again. There are three dredges on the table, one for salt, one for sugar and one for flour.



2.—*Corner of kitchen showing various means of saving steps.*

On the inside of the open door of the cupboard notice the bag for waste papers, strings and paper sacks. In this cupboard cooking utensils are kept free from dust. The shelf at the right affords a large space for unwashed dishes, and the table at the left of the sink a place for clean ones until they may be put away. It is desirable that this space for dishes should be large.

A drop shelf is convenient and saves room.— If the kitchen is small, a drop shelf is often used to advantage and is easily constructed. It is simply a shelf attached to the wall by hinges, and a prop fastened to the shelf by another hinge. This prop then falls into place easily and the shelf is against the wall when not in use.

The work confined to a small space.— Attention is called in Fig. 3 to a kitchen arranged so as to confine the work to as small a space as possible. The window box is seen at the right where all of the perishable provisions are placed. Next is the little stove where much of the cooking is done. The zinc covered table provides space

3.—*Corner of kitchen arranged to confine work to a small space.*

for dish washing and the preparation of foods. Few steps are needed to secure the various utensils, for they hang within easy reach.

Cover the tables with zinc.— It is desirable to have the tables covered with zinc, as they are much more easily cleaned, and afford a smoother surface for work. A trap door in the floor with a hopper underneath connected with the drain affords a convenient place

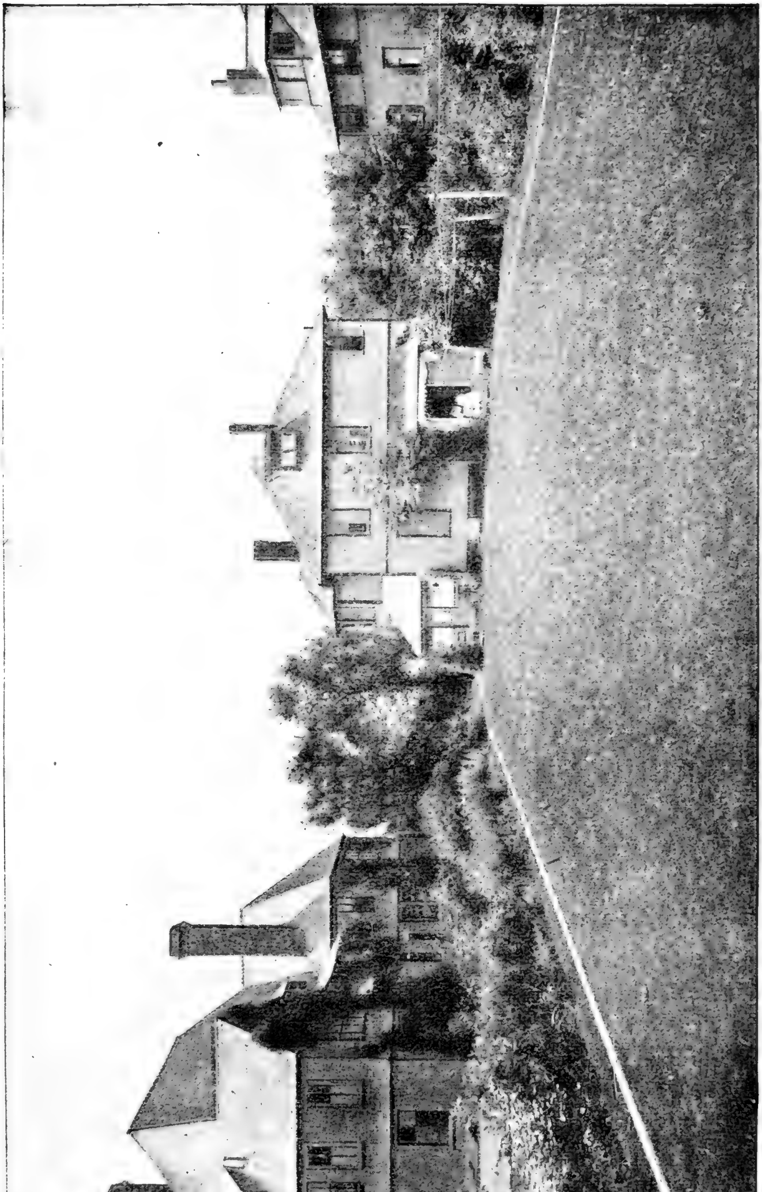
to empty wash water and admits of putting more water on the floor for scrubbing. A dummy constructed with shelves which can be raised from and lowered into the cellar through the floor saves much traveling up and down stairs.

Much depends upon a woman's saving strength.—The home is the center of the universe. Woman is the center of the home. Civilization, therefore, is dependent upon her health and her stimulating influence. All household improvements which can be provided to conserve her strength will add to her power and efficiency.

We would like to have the benefit of your experience in the household problems: the ways you have found of saving steps, and to know how you are securing helpfulness in this direction from your children.

Reading in the home.—We also wonder what you are reading during the winter evenings and if you will encourage us by your replies we shall endeavor in the next lesson to discuss other matters of interest in the home.

If you are reading, what do you find the most helpful and interesting? If you are not reading, why? Is it lack of time, lack of books or lack of interest?



ITHACA, N. Y.

DEAR MADAM:

It has been the aim in the Lesson on *Saving Steps* to meet the conditions as found in the usual American farm home. We desire, however, to interest all women who are home keepers. The Lesson is necessarily general in its nature, and each woman has her own problems, many of which we have not touched.

We therefore ask you to study conditions in your own household and determine what can be done there to make the work easier than it has been either for you or for those who do your work.

Housekeeping is a fine art and it was never intended that a woman's health and happiness should be sacrificed in doing that which to do well is elevating and essential to the comfort and happiness of the human race.

We are dependent upon you for help. Your letters will be the stimulus and the necessary assistance which will make the Woman's Reading-Course a success. Will you undertake your own home problems; tell us how you solve them, and write if we can be of any assistance to you?

Very sincerely,

MARTHA VAN RENSSELAER.

CORNELL READING-COURSE FOR FARMERS' WIVES.

Issued by the College of Agriculture, Cornell University, Ithaca, N. Y., in the months of November, December, January, February and March.

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READING-LESSON SUPPLEMENT NO. 2.

For Farmers' Wives.

APRIL, 1901.

BY MARTHA VAN RENSSELAER.

HOME SANITATION.

I. The Old Farm Home as It Was.

A farm house of the forties, low, narrow in front and extending far back into the yard, stands just under the hill shaded by a thick foliage of locusts. The windows are fitted with small old-fashioned panes of glass, showing from without the dark closely drawn shades. The front door and windows are closed in winter to keep out the cold and in summer to exclude the flies, and to keep the room dark and cool. The half story above discloses small windows which are shaded not only by the locusts and willows but by a picturesque clematis that twines over the surface of the outer wall. The soil about the house is damp and springy. Grass is driven from the doorway for want of sunlight, and mosses thrive upon the roof. Not far from the house and on higher grounds is the barn, of the same age as the house, with a spacious barn yard, in the centre of which, with the ground sloping towards it, is a large watering trough. The cows stand up to their knees in mud. A rim of sod, close up to the fence, is the only safe though circuitous path to the barn. From the big pen between the barn and the house comes the satisfied grunting of the pigs, which is mingled with the gobble of the turkeys and cackling of the hens as they roam over the yard. On the other side of the house is a half pond and half swamp where the ducks dive their heads in deep and the frogs sing to the micro-organisms a soothing lullaby. At the corner of the house stands the old rain barrel, the joy of the mosquito and an offense to the nostrils during dry weather. Where the eaves did not feed the barrel they have emptied the water over the door yard from the

moss covered roof and the water has percolated the soil until the only product is moss and myrtle.

The brook as it goes "on forever" may at once be a joy and a menace.— A brook running near must be Tennyson's own and says as it goes

"I chatter over stony rills."

"I come from the haunts of coot and hern,
I make a sudden sally and sparkle out among the fern,
To bicker down the valley,
* * * *
By twenty thorpes, a little town and half a hundred bridges."

But before it joins the brimming river it "chatters over stony rills" to the pasture land and the edge of the meadow not far from

this house of Farmer James. Here, when the cows are in pasture, they satisfy their thirst, and under the shade of a large tree they stand in the water in the heat of the day.

Its head waters are gathered from swampy land several miles away, where there is a strong suggestion of miasma. It is in the region of a tannery and waste products are poured into this swamp. As it travels it widens into a little stream which here washes over a dairy farm, furnishing drinking water in the barn yard and the water with which the cans are washed. Now it receives the refuse from a large boarding house. It flows through the village as a reservoir for sewage and is dammed below for a duck pond in summer and an ice pond in winter. It receives another lease of life and reaches the farm yard, innocent in appearance but full of poison and badly vitiated.

A great source of danger and a cause of discomfort and illness. — The outside closet is fifty feet from the house. The grass and weeds grow close to the narrow path in summer and in winter the path fills with snow. The door swings hardly shut on its worn hinges and the snow or rain is drifted in. In rain or melted snow, great drops of water fall from the eaves in front of the door. Bare and exposed, its unscreened outlines suggest discomfort.

How to make a rich soil for bactaria.— At the side door for many a year a woman has appeared several times a day to fling as far away from her as possible the contents of a dish-pan. Mondays during these years she has done the family washing on the porch and thrown the water on the same spot. Here the men stop on their way to meals, fill the basin with the refreshing cold water from the well near by, bathe their hands and faces and add the contents of the basin to the dish-water and wash-water. Here the hired man, returning from the factory, washes the milk cans and empties the water. The bacterial crop of the dish-pan, wash-tub, and milk-can fight each other, thrive, go deeper and deeper and finally rejoice in the moisture found near the well.

An inundation in the cellar causes confusion.— Every season there is an overflow of water in the undrained cellar at which time the housekeeper picks her way over boards to the potato bin and

apple barrel. When the inundation comes, barrel-hoops, wash-tubs, turnips, onions and apples are loosed from their resting places and float upon, or sink beneath the surface of the water. Accidents happen to the milk, pork and vinegar. When the water subsides, it is spring time, and the decaying cabbage, potatoes and onions lend their disagreeable odors to those of the gases escaping from the damp soil.

The clothes line hangs across the yard in the rear of the house and a woman pins a light shawl over her head, goes in a heated condition from the steaming wash-tub to the snowy pathway and with the wet clothes stiffening in her fingers hangs them on the line to freeze harder before drying. The result on many occasions is a disagreeable cold from which she hardly recovers before the next wash day.

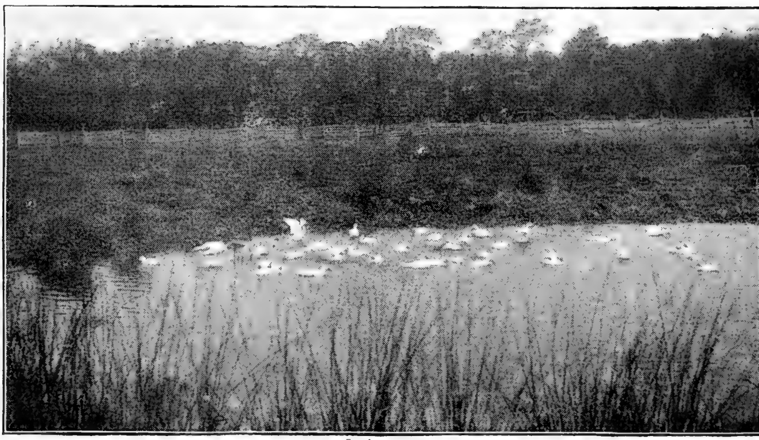
Unused parlor and "spare" room.— The parlor, always closed, is musty and damp. The little sleeping room adjoining is used only for the occasional guest who shivers between the sheets and is kept awake by the smell of must and disused bedding. The rooms are filled with bric-a-brac and heavy draperies which serve as a lodging place for dust. An ingrain carpet covers the floor. It was bought in the earlier days when carpeting was of better quality and the colors are bright and the figure large. The housekeeper religiously stirs up the dust on the sweeping day only removing it from its resting place of the week before to allow it to settle in new spots.

The children hug the sheet iron heater during the evening with backs cold and faces warm and dread going to their sleeping rooms where the snow drifts in, if the rooms are ventilated, and where they lie awake shivering until they "warm the bed" or sleep makes them forget they are cold.

There are many dark corners and dark closets where dangerous dirt has accumulated and where mice and moth escape the eye of the most diligent housekeeper. The space underneath the kitchen sink is encased with boards and it is difficult to clean around the pipes. Dirt and damp have full sway and one is reminded of the old expression "Where daylight cannot enter the doctor must."

II. How to Improve the Farm House.

Farmer James and his wife have lived in this home fifty years amid varying prosperity and adversity. They have had seven children, two of whom died in infancy with cholera infantum and two at the age of sixteen and nineteen with fever. It has never occurred to the family that conditions in or out of the house could have caused these deaths, and in bowing to the decree they thought themselves yielding to an all-wise Providence. Resolutions of respect always are more readable when they say, " Whereas an all-wise Providence has removed from our midst," instead of " Whereas abad drain, impure drinking water and no ventilation."



Happin'ss for ducks, unhealthiness for men.

Eyes opened to need of sanitation.—Their son John came home from college for a holiday vacation. The old home and the home folks were very dear to him, but as he came up the lane he viewed the whole scene with a feeling of uneasy discontent. He had learned the importance of pure soil, pure air and pure water. While the farmer was a progressive man and his wife a thoughtful woman, they had accustomed themselves to surroundings which John determined to change for the sake of the health of the family.

The neighborhood is roused on the subject of sanitation.—Then, too, at several farm houses in the neighborhood there were summer

boarders who had asked numerous questions regarding the source of water, condition of soil and ventilation. These visitors had come from the city to regain health, and were thinking not so much about the danger from disease germs they had brought with them as the proper conditions in the country for getting rid of them. The neighborhood was thoroughly awakened upon the subject, and the excitement grew greater when it was learned that scarlet fever had broken out in a small village through which the much loved brook found its way.

The father and son put their heads together and drew one plan after another without settling on any, before it occurred to them that it might be well to consult the women concerning this house, since they occupied it most of the time. These consultations prevented many mistakes which only a practical housekeeper would notice.

John explained how impurities may be transmitted by the porosity of the soil and how germs of disease may float in the air. The soil all these years had received neither tillage nor drainage. Organic matter — matter once living, now dead — had been falling upon it, loading it with impurities, while the house and its occupants had received the disease-laden gases made from constant putrefaction.

An outside drain improves the cellar and dooryard.— They decided that the site must be drained. They dug a trench on all sides of the house from which water flowed towards it at a depth below the level of the cellar bottom. In this was laid a tile drain which led to the brook.

Then Mr. James said, "I wonder if that cellar is the cause of the fever the hired man has gone home with." Mr. James knew that the only way to reduce a death rate was to consider the conditions for health. He was haunted by an expression he had heard, "A damp cellar weaves shrouds for the upper chamber." He was wise enough to see that he could get no richer returns for his money than to secure healthful conditions at home.

They decided that the cellar should extend under the entire house, because a greater amount of ventilation and dryness could be secured, and because a larger one was needed for storing provisions.

A closet was built for milk and butter. Bins were provided for storing the potatoes and vegetables. The walls were whitewashed; the ceiling was high. Windows easily opened were placed opposite each other. Another important addition was a cement floor which proved very durable since the cellar would be made dry by the outside drainage.

How to secure pure water and how to dispose of refuse are problems for the farmer.— Probably the most difficult problem they had to consider was how to dispose of the slops without pollut-

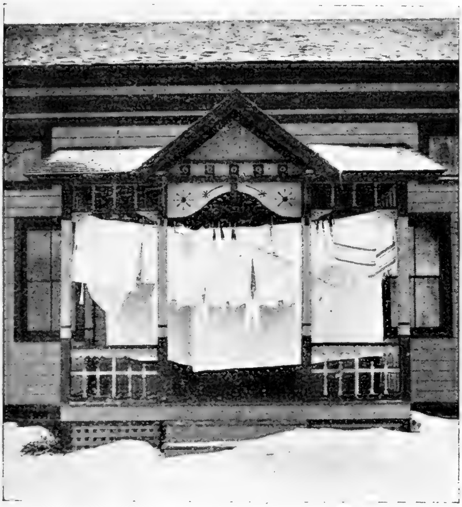
Chilly work on a blue day.

ing the water supply. There were serious objections to a cess-pool. However, the only alternative was to have a small pipe attached to the kitchen sink. This with trap connection (See Lesson I) united outside with a larger vitrified pipe which also received the wash water from a funnel on the back porch. This drain emptied into a cess-pool a long distance from the house and on lower ground.

The well on this farm had always furnished cool and refreshing water and although Farmer James had some misgivings, he was much relieved when the visiting physician had given the matter no

attention at the time the hired man took the fever. John observed that the family is less isolated than formerly, the children go to school, they have more company and since the prices of farms have improved, a larger number of prospective buyers have come to inspect the farm, while peddlers, hired help and tramps are frequent visitors. There was therefore danger from typhoid and other disease germs finding their way to the drinking water. They had a dug well. The wash and dish-water were thrown near it and John said there was danger of pollution from household and barn excreta.

They decided that a drilled well was the safest and cheapest of all. This would furnish the drinking water for the family, but it was too hard for household use. They planned a cistern under the steps 6 ft. deep and 5 ft. wide, covered with two layers of plank. This was lined up to within a foot of the surface of the ground with water lime cement without the use of brick or stone as the subsoil was hard and tenacious. An outlet was furnished near the surface by a pipe leading to the brook and another pipe connected the cistern with a pump in the kitchen.



Comfortable surroundings lighten hard tasks.

Large, well-ventilated sleeping rooms conducive to good health.— They decided to raise the roof and have the second story extend over the entire floor with higher ceilings, larger rooms and better windows; the chambers would thus be made healthful and comfortable in cold weather. Where windows could not be had in a closet they were to place transoms over the doors and where these were impracticable the closet could be so arranged that the door on being opened would let in the light from an opposite window. John knew each member of the family would appreciate the difference

in the vigorous, healthful sleep in a well-aired, comfortable room and that in a room where the air is close and stifling.

Promote health and happiness by cleanliness in and about the kitchen.—John discussed with his mother the dangers from dust which might be laden with bacteria. They decided that the draperies and bric-a-brac should be replaced by white wash curtains and fewer, more simple ornaments. John explained also that the "bacteria of the dish cloth" might be a dangerous source of pollution. As a precaution against the accumulation of grease and the clogging of the pipes, Mrs. James now had in her sink a fine sieve through which the water was poured. This was cleaned often and the contents burned. Before emptying liquids into the sink which might leave on the sides of the pipes a greasy deposit, she allowed them to stand until cool and removed from the surface the coating of grease, the cleanest of which was utilized for soap making or other purposes. They planned to use small pipes in connection with this sink, because the velocity of the water thus became greater to wash out the dirt which otherwise would collect.

Make every room a living room.—The doorway between the parlor and guest chamber was to be enlarged and the little room added to the larger one as a cosy sitting room though having still possibilities as a guest chamber. The parlor wool carpet was sent to the weaver's to be converted into two rugs, one for the larger room and a smaller one for the cosy. The cracks of the floor were to be filled with putty and the floor painted a rich dark color. A great advantage would be gained in that the former hard sweeping and dusting would be reduced to the lesser work of placing the rug on a line outside, to have the dust whipped out and the floor wiped with moist cloths.

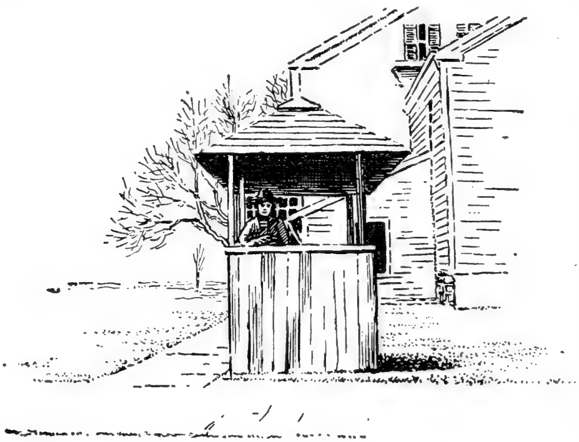
The old stoves were to be replaced by better ones whose dampers would prevent the access of air. John showed how the stoves regulated by dampers in the pipes exhausted the oxygen and drove the burned air back into the room.

A fireplace brings comfort and cheer in its warm glow and takes away injurious gases.—"The fireplace is a waste of heat and does not warm the rooms in very cold weather," Farmer James reasoned.

"But then," John said, "it is an excellent ventilator and there is abundant fuel supply on the place. The rooms are easily ventilated in summer, but in winter the fireplace will supply the demand, besides adding greatly to the attractiveness of the rooms."

III. The Farm House After Improvements Are Made.

When the June days come, John returns from college anxious to see the changes on the old farm. A few trees with luxuriant foliage wave in the sunlight, and give a grateful shelter with a sense of repose and comfort. A dry, firm, grassy sod extends over the yard



Health, hospitality and refreshment.

and comes to the edge of the gravel walk. The June roses, massed at the side, are in full bloom, filling the air with a delicious fragrance. A wide veranda extends across the front of the house offering ease and hospitality. Doors and windows are flung wide open. Mosquito netting and wire screens shut out the unwelcome fly. The breezes play with the white curtains and waft into the house the odor of honey-suckle and wild rose,—a grateful change from the musty, stifling air of the old parlor. On the surface of the pond, a little way from the veranda, cleansed of its slime and filth, fleeting shadows of fish play fitfully, while on its surface are mirrored the cat-tails and bushes which fringe the bank. The ducks dive among

the lily pads. A rustic bridge spans the little brook which is now bordered with forget-me-nots.

The well, driven deep into the rock past all danger of pollution, has built over it a covering which affords a shelter in time of storm and furnishes a refreshing draught to the weary passer-by. Across the side veranda hangs the week's wash, the line strung from end to end, out of all danger of exposure to the housekeeper.

The out-buildings have seemed to withdraw and retreat out of view, but are still convenient to reach; the pathway to the closet is protected from the storm and shaded by a trellis covered with vines.

If John had loved the old home, how much more could he care for this one? They all delight in the rest which comes at the end of the day in the delicious coolness of the nights on the open veranda, and in winter the reveries, the reading aloud, the stories told around the fireplace with the weird shadows of the burning back log and the crackling of the hickory. Farmer James said: "It is better to have our money bringing health and happiness than yielding interest at the bank."

IV. What Our Correspondents Say.

Dry wood is a saving of money, time and steps.—"We always have dry wood. My husband thinks it is money out at interest. If you want a good fire you can surely have it, and if you do not need very much fire one stick with stove shut up good will burn a long time. In summer I burn oil. This saves many steps."

Reading adds to the pleasure of the farmer's wife.—"The reading of the farmer's wife may add more to her pleasure than almost any outside influence. A daily, a good semi-weekly, or even weekly paper, keeps her in touch with events all over the country. It is surely not extravagant to take one magazine for general reading. I know that a farmer's wife has little time for reading, but, when tired, ten minutes spent in reading is a good investment. The rest physically and mentally helps to make the next task so much easier."

"I find by forethought I can accomplish a good deal before breakfast. I try to get the beds made, rooms swept and dusted, lamps cleaned and chickens fed before the men come in to breakfast. We have a great deal of company and, of course, everyone

adds to the work, yet I do not want to live without the society of my friends. Sometimes I let some of the cleaning go and when very tired sit right down and read a few pages in some good book or paper and it rests me more than I can tell. In summer we women should save ourselves much cooking over hot stoves, as the fruit is much more healthful than so much pastry. I enjoy the life a farm offers, if only we could get a little more time and not quite so much hard work."

"*Think twice and step once.*"—"My husband gets the water, empties the tubs, stretches the line and hangs the clothes. I call that saving steps. We find plenty of time to read, as all work is laid aside after supper, the table is set out, our rockers are drawn up before a large open fireplace and we read until we are tired. I am glad to learn all I can to save steps. A woman's motto ought to be: Think twice and step once."

Enjoy the sunshine and fresh air.—"In winter time it is well to keep all decayed fruit and vegetables removed from the cellar, as it is often the cause of disease as well as hastening the decay of sound fruit or vegetables. Be sure and not shut out any sunshine or fresh air. It is the lot of nearly all farmers' wives not to be able to get out in the pure country air as much as we need to keep good health. We should seek the invigorating morning air."

Farmers' wives need recreation.—"So many farmers' wives feel they have no time for recreation that they cannot belong to any society, where if they did it would make their steps lighter and they would plan to save steps in order to be present with their associates."

How shall boys be trained to be helpful.—"I would like to ask the opinion of others on how to bring up my boys to keep the things they use picked up, so as to save my steps. I do not always like to be nagging at them and it seems very hard for them to remember to put away their things after they are through with them."

What can women do about sanitation?—"There are many and varied needs along sanitary lines that I see in my own home and in those of my neighbors which belong more to man's work than to woman's, and I am at a loss to know what women can do toward repairing draughty houses, providing suitable drains, etc. The only

thing I can see for them to do is to urge the men to take an interest in such things and get them to fix them. Ventilation is not so much a problem in farm houses as how to curtail the same."

Spend the spring days out of doors.—"To-day, when I swept, I gathered up trinkets, dusted them and put them together in one basket. One trip removed them from the room when formerly five or six were made. A woman told me that she would not fill all the lovely days of spring with house cleaning and hard work. A beautiful orchard came up close to the house and a door opened from the house upon it. She used to plan to keep the days, when the blossoms and birds filled the place, as free as possible, so that she might spend much of her time there. I have often compared her with the women who work and worry during that lovely season and scarcely hear a bird or see a blossom."

Confusion and worry add steps.—"We have a very large house, and, like many other old houses, it was built a part at a time. The cellar opens from the dining room, quite a distance from the kitchen. The pantry also opens from the dining room, consequently there is much chance in my work to take extra steps. It is when everything is in confusion and the worker is disturbed and nervous that she takes two steps where one would answer the purpose."

Take one day's burdens; let to-morrow's wait.—"My kitchen table is covered with table oil cloth rather than zinc and several little round wooden mats always in reach for hot dishes. I consider a dish drainer one of the necessities. I have a large wooden one by the sink with two slats running lengthwise through the middle for the dishes to rest on after washing. It is a drop affair and fastened to the wall with hook and staple. Lastly, let me add the earnest advice to dispense with washboard and get a Western washer (I am not advertising) and have some male member of the household to assist for one hour on washday morning. I would manage to change work if I could not secure this help in any other way. It is not hard work for a man, but unsuitable for a busy housekeeper. A cheerful spirit is a great panacea for all ills. The same amount of work when the spirits flag, drags like a ball and chain, and woman's work appears the everlasting round of daily duties, never ending.

Take only one day's burdens. Let to-morrow's wait. Seek companionship with congenial friends or neighbors if you have them and books. If possible, join a woman's club (don't be shocked), literary or for mutual improvement in any desired direction. It will help you work, talk and keep you sunny hearted, if it is wisely directed. In these days even five people who agree to study a few months can have with very little expense a library from our State department at Albany. No one needs the rest and stimulus this will bring more than the busy housekeeper. If it seems impossible to meet the club, induce them to meet at your home, where you may keep the books and book-cases."

The Story of a Busy Life Briefly Told.

A busy woman who has time to read.—" Two things I have been taught in my long farm life; one is that work never kills and the other is that we must calculate work beforehand in order to save steps and do a great amount of work. I am fifty-eight years old. Have been on a farm all my life until a year ago when we built a new house on one end of our farm which opens on a public road and retired from farm labor. My father was a farmer and a minister of the old school who believed in no salary but believed in working for a living. I learned to milk when seven years old and always did my share while at home. I was sent to school, but at fourteen commenced to teach a district school on a third grade license. I soon received a second and then the first grade. I boarded around. I was married at nineteen and then my farm life began in earnest. We always kept a dairy, from twelve to fourteen head. When we were married we did not own a foot of land. My husband and I bought thirty acres the day after we were married, joining the old homestead of his people with whom we lived. They owned fifty acres, but there was a mortgage of $350 on that. We took care of them until they died, paid the mortgage, bought enough more to make us two hundred acres. We had a sugar orchard and made from three to five hundred pounds of sugar and a great deal of syrup every year. We kept sheep and always worked up the wool, spun, wove and made full cloth for men's wear

and for flannel sheets. We knit our own socks and stockings. I would always rise in the morning at four or half past, winter and summer, and have built my own fires, milked from four to eight cows, prepared the breakfast and had it at six. Until about ten years ago we made butter and since then have sent it to a factory. I always did my own churning, and many are the books of poems, histories, stories and newspapers I have read through while churning. I am the mother of eight children, five of whom are living. The others died when small. The oldest living is thirty-six and the youngest is twelve. Three of them have graduated from high school and been a number of terms at an academy. One has been for five years at Cornell University. I have always done my own washing and weaving of carpets as I have a large house and it is furnished with rag carpets. I make my own garden and have helped raked hay and husk corn. One fall alone I husked between five and six hundred bushels. I had one daughter and she was at home at that time; so I did no housework while husking, although I attended to the milk and butter, milked and got breakfast. One summer I piled up one hundred cords of wood and did my own housework. You will say there was no call for this. We were married the first year of the Civil War. In '63 my husband was drafted, paid his $300 and stayed at home. That had to be met in hard times for the farmer. Not many modern wives would think they could pull flax, cut corn, dig potatoes and do all things on a farm that we used to do. All this time I had a hired girl only a year and a half. We made our own table linen and toweling, spinning and weaving it, and our flannel dresses. I did not find much time to gossip with neighbors, but have been with the sick a great deal, and always went to church and Sunday school and attended societies which belonged to the church. To day I can walk a mile or more as quickly as any one. At the present time I have two old people to care for; one of them is eighty-six and the other is eighty-three. There are five in our family, and I am doing all the work myself, and am going to take the teacher to board next year. So you see work does not kill and there must have been some calculation to save steps. My husband says, 'You helped earn and saved

more than I did.' The boys many times say, 'If it had not been for your pushing and helping us to school, we never could have done so well.' All this time I have kept up with the general reading of the day. I never counted my steps but once, and that was when I spun a skein of woolen yarn. I went a little over a mile."

ITHACA, N. Y.

DEAR MADAM:

The lesson on Home Sanitation is only suggestive of conditions which exist in some farm homes. In many cases it is impossible for you to overcome the difficulties of which you have long been conscious. Correct sanitation appeals strongly to women, and they possess the ability to change many things which threaten the lives and health of the family. Inasmuch as women give more attention to these matters, the safety and health of the family fall heavily upon them. We are asking you to seek patiently, even though it takes a long time, for the conditions which supply pure water, pure air and healthful soil. We do not wish to reflect upon the mode of living of any one, but simply to arouse thought and attention to existing evils. There are problems in the farm-home regarding the sanitation which the village and city is not forced to meet; and while the difficulties may seem insurmountable at times, the effort is noble and the work is characterized by the spirit which pervades the highest type of the world's work — that which ministers to human happiness, bodily, intellectually and spiritually. Woman is the guardian of the health of mankind. She is not divine. She cannot perform miracles, but she can by good sanitation destroy germs and thus prevent disease.

Will you not study in your own home to obtain in as many ways as possible conditions which will secure healthful living. We hope to hear from you and to know the difficulties from your standpoint.

Nearly six thousand women in the State of New York are enrolled in the Women's Reading-Course. It was the intention to issue a bulletin this spring on gardening, but there is a limit to the appropriation and for that reason further lessons cannot be issued before fall. However, the correspondence will be continued and we hope to keep up our acquaintance in this way until fall, when we

shall have more frequent communications in the way of printed lessons.

We should like to have you send us the names of any farmers' wives who will be interested in the Women's Reading-Course. All suggestions which will help us to make this course practical and fitted to meet the requirements of the farm-home will be appreciated by us.

Very cordially,

MARTHA VAN RENSSELAER.

Beginning with the right spirit.

Circular 20. **December, 1900.**

Cornell University College of Agriculture and Agricultural Experiment Station,

ITHACA, N. Y.

AGRICULTURAL AND CHEMICAL DIVISIONS.

I. P. ROBERTS, Director.

CONCERNING

CO-OPERATIVE EXPERIMENTS,

By J. L. STONE.

Published under the provisions of chapter 430 of the Laws of 1899.

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CO-OPERATIVE EXPERIMENTS.

Purposes and Methods of Conducting Them.

Experiments conducted by farmers in different parts of New York State under the supervision of the College of Agriculture of Cornell University, have been in operation for several seasons. These experiments are a part of the University Extension Work in Agriculture, and the results obtained are of such a character as to warrant further organization and enlargement of the work. That the farmers may more fully understand the objects and scope of the work and also to facilitate its extension, the present brief statements have been prepared.

Value of the data obtained.

The Experiment Stations have been busily at work for a number of years and have accumulated a vast amount of data that is of inestimable value to scientific and practical agriculture. Farmers everywhere are coming more and more to look to the Stations and Colleges for the solution of their difficult problems and for advice when undertaking any new agricultural enterprise. But differences in soil, climate or facilities for work often render it uncertain whether the results obtained on the Station and College grounds will be verified in actual practice on the farms throughout the State. This is particularly true in regard to experiments with fertilizers. It is now universally conceded that the only way a farmer may know what constituents of commercial fertilizers, if applied to his soil, will produce an increase of crop is by making a trial, on small areas, with the various chemicals and carefully noting the result. Furthermore it is known that a field at one time well supplied with a particular element of plant food may, by cropping or bad management, become depleted in the same. Hence one experiment with fertilizers on a certain soil will not suffice for all time, but must be repeated at intervals if the farmer is to treat his soil intelligently and to secure profitable returns.

It is therefore important that arrangements be made whereby farmers may make soil tests with fertilizers at small expense and have instruction and assistance so that the results shall be trustworthy guides in actual farm practice. Such an arrangement has been made by this College and is described more in detail at another place in this circular.

Again, it is well understood that a difference of yield equal to 25, 50 or even 100 per cent often results simply from a difference in the variety of the crop grown. But these varietal differences are not constant in different parts of the State. The Station is constantly making more or less variety tests, but not to the extent that would be done if it were felt that results obtained on the home grounds are of certain application to large and widely separated areas throughout the State. It is believed to be the better policy for the College to encourage and assist the farmers to make tests of recommended varieties of the crops they grow on their own soils. The same is true in regard to the introduction of new crops or those that have not heretofore become widely disseminated throughout the State. It is desired to keep in touch with farmers growing such crops, that conditions of success and failure may be noted.

Educational value of Experimental Work.

Many farmers do not read the bulletins published by the Stations, or, if they read them, are not sufficiently impressed with the suggestions contained therein to be led to endeavor to put them to a practical test. What they see upon their own or their neighbor's farm has much more influence with them than what they read concerning results obtained at the College farm. Hence the desirability of every farm being, to a certain extent, an experiment station. Not only are the facts made more real, but the educational effect of an experiment upon the persons conducting or observing it is of no small importance. Probably no one thing will account so much for the failures among farmers as the lack of habits of accurate observation. They guess at results, or judge by appearances, instead of making accurate weights or measurements. They will judge the effect of a certain fertilizer, for instance, more by the appearance of the straw or vines than by the yield of grain or

potatoes, which are seldom accurately known. A difference in yield of fifty bushels per acre of potatoes will scarcely attract attention as they lie in their places on the ground after digging.

In the personal experience of the writer these statements have been abundantly verified. On one occasion a field was planted to early potatoes, there being applied 700 lbs. per acre of a high grade complete fertilizer costing $40 per ton. As was the custom under such circumstances, some rows were left unfertilized for comparison. At harvest time the workmen were instructed to dig fertilized and unfertilized rows, leaving the potatoes in their rows side by side for examination. When ready the writer inspected them carefully and while there was a slight difference observable, the verdict rendered as the result of inspection only, was, "Not enough increase to pay cost of fertilizer." Pressed with work, the impulse was to have the potatoes picked up without further care, but a wiser thought prevailed and a definite area was laid off and the potatoes from it carefully measured, when, to the surprise of all, the yield of the fertilized rows exceeded that of the unfertilized by 62½ bu. per acre.

This occurred in August and these potatoes had a ready market at ninety cents per bushel. The value of the increase was $56.25 per acre. The cost of the fertilizer was $14.00 per acre, and, if $2.00 are allowed as the cost of applying the same, the total expense on account of fertilizer was $16.00 per acre, leaving $40.25 as net profit. And yet we were on the point of turning away from this experiment saying "the fertilizer does not pay."

After some experience in experimental work, farmers come to know that "judging by the eye" is entirely unreliable, and will adopt more accurate methods much to the advantage of their business.

Closer relations between Farmers and the College.

Aside from the value of the data obtained and the educational effect upon the farmer, these experiments are valuable as a means of bringing the College and the farmers into closer relationship. The College and Station staff need to know more of the farmer's successes and failures and of the problems that are perplexing him. They are thus enabled to direct their investigations along lines that will be more directly help-

ful to the agriculturists of the State. The farmers, as well, by reason of personal association with College representatives, come to appreciate more fully what the College can do for them and where to go for help when difficult problems arise.

Co-operative experiments arranged.

The above considerations have led the College of Agriculture to arrange for co-operative experiments with fertilizers and with a number of farm crops of importance in the State. The effort has been to select those questions for investigation that will be of practical value to large numbers of farmers and to arrange them in such simple form as to be easy of execution. The plan is to arrange experiments along a number of different lines and to let each experimenter choose that in which he is most interested or which will be of the most practical value to him. It is intended that a College representative shall visit the experimenters during the season, so far as time and opportunity shall permit, but it is not intended to limit the number of experimenters to those who probably can be visited. It is hoped that a large number of farmers will avail themselves of this opportunity to get help in regard to many questions that have to do directly with the success or failure of their own farm operations.

Soil Tests with Fertilizers.

Many thousands of dollars are annually paid by the farmers of New York for commercial fertilizers. In most cases the farmer buys some brand of complete fertilizer without any definite knowledge that it supplies most cheaply and abundantly the element of plant-food most deficient in his soil, or that he is not paying for expensive materials that are already abundant.

The College desires to encourage the farmers of the State to make tests of various fertilizing material on their soil to learn which, if any, or what combinations, will produce profitable results. During the past four years, in order to encourage this work, the College has furnished many sets of experimental fertilizers to farmers, has instructed them as to manner of conducting the experiment and in most cases has inspected the work during the season. A partial

report of these experiments was made in Bulletin 179. A noticeable fact developed by these experiments is that the conclusions reached on one farm are rarely applicable on another, but are of real practical value where the experiment was conducted.

These experimental sets of fertilizers are not to be had on the general market, though farmers buying the chemicals in the usual packages may weigh out the required amounts for their own use. Usually they will prefer to receive them ready for use through arrangement with the College of Agriculture.

During the past seasons the College has supplied, free of cost, the fertilizers used in the experiments. The funds available for this purpose are so limited that not nearly all the farmers who desire to make the tests could be supplied, and of course only a small fraction of those who ought to do so. It has been decided for the next season, instead of supplying sets of experimental fertilizers free to a few farmers, to make arrangements whereby all farmers who desire, or can be induced to take up the work, can secure the fertilizers at small cost — that is at the market price of the goods plus the extra cost of putting up in sets. Each set consists of two large sacks in which are seven small sacks containing and labeled as follows:

Plat 1 — K...... 15 pounds muriate of potash.
Plat 2 — N...... 20 pounds dried blood.
Plat 3 — P ..... 30 pounds acid phosphate.
Plat 5 — NK ... 35 pounds mixture of 20 pounds dried blood. 15 pounds muriate of potash.
Plat 6 — PK.... 45 pounds mixture of 30 pounds acid phosphate, 15 pounds muriate of potash.
Plat 7 — NP.... 50 pounds mixture of 20 pounds dried blood, 30 pounds acid phosphate.
Plat 8 — NPK.. 65 pounds mixture of 20 pounds dried blood, 30 pounds acid phosphate, 15 pounds muriate of potash.

The contents of each small sack are to be applied to a corresponding plat of land. These plats may be one-tenth or one-twentieth of

an acre each, according as it is thought desirable to apply medium or heavy applications of fertilizers. Usually for test purposes the small plats are more desirable. No fertilizer is furnished for plat four, which is reserved as a check with which to compare the other plats. This check plat is more important than any other single plat and must not be omitted from the experiment.

The College has arranged with a reliable firm to furnish the above described sets of experimental fertilizers at $4.00 per set, subject, however, to change to correspond to change in price of chemicals. It is to be hoped that a large number of farmers will avail themselves of this opportunity to determine which elements of plant food produce, on their soils, increase of crop. The price being practically the same as they would pay for the same plant food put up in the ordinary trade packages, the cost ought to be no objection. The experimenter may grow any crop he desires upon the fertilized plats. Corn or potatoes are particularly well adapted, as they are usually harvested by hand. Beans, wheat, sugar beets or buckwheat are also suitable crops.

Those desiring to make this experiment will please write to this office for an order for an experimental set of fertilizers. This order they will forward with the cash to the firm with whom we have arranged and the goods will be promptly shipped. The only object in having the order issued from this office is that the College may keep in touch with each experimenter, may furnish him with needed help and, so far as practicable, may visit him during the season. Instructions for conducting the experiment and blanks for reporting results to this office will be forwarded with the order. Applications for orders should be forwarded early, as the goods must be prepared in quantity and it may not be possible to supply a small number of orders arriving late in the season.

Cultural Experiments with Potatoes.

Excellent results have been obtained on the Cornell University Experiment Station grounds for a number of years in growing potatoes by a system of *thorough tillage* (manures and fertilizers being omitted to emphasize the tillage). Circular No. 18 (Potato Culture)

gives a brief summary of this work and suggests a series of co-operative tillage experiments embodying the methods that are believed to have contributed to so high a degree of success on the Station grounds. It may not be practicable in every case to secure all the conditions that are thought desirable, hence the experiment is arranged in six parts, any number of which may be combined in the experiment as circumstances permit. These are:

No. 1. Autumn vs. spring plowing.

No. 2. Twice plowing vs. once plowing.

No. 3. Early vs. late spring plowing.

No. 4. Deep planting and harrowing before plants are up vs. shallow planting and without working till plants are well up.

No. 5. Prolonged, frequent, level tillage vs. "laying by" at third cultivation.

No. 6. Protection against blight vs. protection against beetles only.

Circular No. 18, setting forth this work more in detail, will be sent upon request and blanks for reporting results will be forwarded to those who undertake the work. The practical value of these experiments is believed to be large and it is hoped that many will undertake them.

Varietal Experiments with Potatoes.

Potato growers know very well that yield is often much affected by the variety planted. Not infrequently a difference of 50 to 100 per cent will result from different varieties planted side by side and treated every way alike. A given variety will yield very differently in different localities and there is quite a marked tendency for all varieties to "run out" or become reduced in productivity. The selection of varieties is, therefore, an ever present question with the potato grower and one upon which his profits largely depend.

The College has arranged to send to a limited number of farmers about one-half peck of each of a number of varieties of potatoes to be tested on their soil. These varieties will be such as have given indications of being valuable in certain parts of the State, but have not been very widely disseminated. These varieties are all

to be planted side by side and along with them such varieties as the farmer already has or can easily procure in his vicinity. All are to receive the same treatment and at harvest time an equal area (preferably $\frac{1}{100}$ part of an acre. See Circular No. 19) of each variety is to be taken up, weighed or measured, and a report of results made to this office. In asking for "seed potatoes" for this experiment, farmers will please state what varieties they already have or can readily procure, so as to avoid duplicating these varieties from the College.

Varietal Tests of Beans and Sugar Beets.

During several seasons coöperative tests of field beans and sugar beets have been in progress under the supervision of the College. Very interesting and valuable results have been obtained, some of which have been published (*i. e.*, on sugar beets, Bulletins 143, 166 and 182). Others will appear soon. The College will send seeds of a number of varieties of each of these crops to such farmers as will undertake to make a comparative test of the same and report to this office results actually obtained by measuring or weighing the crop.

Wheat.

Interest in varieties of wheat among New York farmers seems to have increased of late. The depredations of the Hessian fly and losses from winter-killing bring to the front the question of the resistant powers of the various varieties. This added to the ever-present question of adaptation of variety to locality make it important that a large number of coöperative tests be undertaken. A beginning has already been made along this line and it is hoped to secure the coöperation of a considerable number of farmers in the wheat-growing sections of the State. It is also hoped that a number will select the wheat crop upon which to make the experiment with fertilizers. Those interested will please communicate with this office for further details.

Buckwheat.

In some sections of the State not adapted to wheat growing, buckwheat has become quite an important crop. This crop has received very little attention from experiment stations, and it is

not looked upon with favor by some practical farmers; but it is believed that when the conditions of its successful culture are better understood its value to the State may be greatly increased and the objections to giving it a place among our farm crops may be largely removed. We will be pleased to correspond with farmers who are interested in improving the buckwheat crop in regard to some experimental work with buckwheat that has been planned.

ORCHARDS.

Aside from the above experiments, which are under the direct supervision of the divisions of General Agriculture and Chemistry, there will be others along the line of horticulture under the supervision of Prof. John Craig, who is in charge of the Farmers' Reading-Course and Extension Teaching. A special study is to be begun next spring of unproductive orchards and methods of bringing them into fruit bearing. Those interested along this line will please communicate with Prof. Craig at this office.

It is necessary that persons desiring to take up any of the lines of experimentation described above should early notify the College of their intentions that arrangements may be made for the necessary fertilizers and seeds so that the same may be in the farmers' hands before the rush of spring work comes on.

The enterprising and progressive farmer usually works out a plan of the season's operations during the winter months, and this plan should include each year some experimental work — something that will add to his knowledge of his soil and its capabilities; of the best methods of treating it to get profitable returns, or of the adaptation of various crops or varieties to his locality. It would seem that former students of the College of Agriculture and members of the Farmers' Reading-Course especially should be interested. Those who are willing to co-operate in this work will please address the undersigned at the College of Agriculture, Ithaca, N. Y.

J. L. STONE,

Assistant in Agriculture.

The Following Bulletins are Available for Distribution to Those Who May Desire Them.

40 Removing Tassels from Corn, 9 pp.
55 Greenhouse Notes, 31 pp.
71 Apricot Growing in Western New York, 26 pp.
72 The Cultivation of Orchards, 22 pp.
74 Impressions of the Peach Industry in N. Y., 28 pp.
75 Peach Yellows, 20 pp.
76 Some Grape Troubles in Western N. Y., 116 pp.
78 The Cabbage Root Maggot, 99 pp.
79 Varieties of Strawberry Leaf Blight, 26 pp.
80 The Quince in Western N. Y., 27 pp.
87 Dwarf Lima Beans, 24 pp.
93 Cigar-Case-Bearer, 20 pp.
95 Winter Muskmelons, 20 pp.
96 Forcing House Miscellanies, 43 pp.
97 Entomogenous Fungi, 42 pp.
101 The Spraying of Trees and the Canker Worm, 24 pp.
102 General Observations in Care of Fruit Trees, 26 pp.
103 Soil Depletion in Respect to the Care of Fruit Trees, 21 pp.
109 Geological History of the Chautauqua Grape Belt, 36 pp.
110 Extension Work in Horticulture, 42 pp.
114 Spraying Calendar.
116 Dwarf Apples, 31 pp.
117 Fruit Brevities, 50 pp.
119 Texture of the Soil, 8 pp.
120 Moisture of the Soil and Its Conservation, 24 pp.
121 Suggestions for Planting Shrubbery.
122 Second Report upon Extension Work in Horticulture, 36 pp.
123 Green Fruit Worms, 17 pp.
124 The Pistol-Case-Bearer in Western New York, 18 pp.
125 A Disease of Currant Canes, 20 pp.
126 The Currant-Stem Girdler and the Raspberry-Cane Maggot, 22 pp.
127 A Second Account of Sweet Peas, 35 pp.
128 A Talk About Dahlias, 40 pp.
129 How to Conduct Field Experiments with Fertilizers, 11 pp.
130 Potato Culture, 15 pp.
131 Notes upon Plums for Western New York, 31 pp.
132 Notes upon Celery, 34 pp.
134 Strawberries under Glass, 10 pp.
135 Forage Crops, 28 pp.
136 Chrysanthemums, 24 pp.
137 Agricultural Extension Work, Sketch of its Origin and Progress, 11 pp.
138 Studies and Illustrations of Mushrooms; I, 32 pp.
139 Third Report upon Japanese Plums, 16 pp.
140 Second Report on Potato Culture, 24 pp.
141 Powdered Soap as a Cause of Death Among Swill-Fed Hogs.
142 The Codling-Moth.
143 Suger Beet Investigations, 88 pp.
144 Suggestions on Spraying and on the San Josè Scale.
145 Some Important Pear Diseases.
146 Fourth Report of Progress on Extension Work, 26 pp.
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BUREAU OF NATURE-STUDY AND FARMERS' READING-COURSE.

BEING A PART OF

UNIVERSITY EXTENSION IN AGRICULTURE.

I. P. ROBERTS, Director.

CORNELL UNIVERSITY,

College of Agriculture.

NOVEMBER, 1900.

General Statement.

The Farmers' Reading-Course of the College of Agriculture of Cornell University was organized four years ago. Our reading circle of fifteen thousand farmers has been built up in that time. We believe that the suggestive Lessons issued have been appreciated and have done good work. We are led to this conclusion by the testimony of the readers of the Lessons. We wish to retain all our old readers and to add many new ones in order to make this Reading-Course of still greater use to the farmer. This is legitimate university extension. Farmers may not find it possible to come to the University themselves, but they can co-operate by sending their sons to the University, by helping in the formation of reading-clubs and by bringing their farming difficulties to the members of the staff of the College of Agriculture. If we cannot help you immediately, we will ask your assistance in carrying on experiments designed to solve your problems. The College of Agriculture will then attempt to aid the farmer with direct advice and suggestive hints gathered from its own experience and by direct experimentation on the farmer's fields. Through this latter means the farmer and the experimentalist are brought into close touch to their mutual benefit.

Ground Covered Thus Far.

The Reading-Course thus far has dealt with three fundamental things: the soil, the plant, the animal. A proper understanding of the method of soil formation suggests the way in which its fertility is best maintained; a knowledge of the way in which a plant obtains

its food from the soil and the air and elaborates it in the leaves, emphasizes the desirability of preserving the latter from insect and fungous attack, so that it may perform its life functions in a proper manner; a knowledge of the principles of animal nutrition is essential to the successful and profitable production of beef, milk and butter. These features have been set forth in Reading-Lessons 1 to 10. It is now proposed to specialize somewhat. This is what the college man does in his life work. After building a broad foundation by taking a general scientific course, he applies himself to a single problem at a time. In this way the problem receives his individual attention and he gets so much the more out of it.

Lessons for This Winter.

This winter we propose to take up questions relating to orcharding. We shall devote our first lesson to a consideration of the tree and its manner of growth, and succeeding lessons to the soil, its preparation, the planting and subsequent care of the tree and its fruit. The fruit interests of the State are of high importance. The fruit industry is exceedingly diversified. We have our apple districts, our peach sections, our grape belts, our strawberry and small fruit regions. The amount of capital invested is large. Success usually rewards the cultivator in proportion as the underlying principles of science and good business ability are combined and applied with industrious perseverance. It will be our endeavor in the lessons issued this winter to direct attention to some of these elementary, but essential, truths. Will it not be to your interest to send for sample copies of these Lessons? Let us hope that you will not only do this, but that you will organize a club.

How to Organize a Reading-Club.

The formation of a Reading-Club is a very simple matter. Let some one write us for information regarding this Reading-Course and the methods employed in carrying it on. We will gladly send him the desired information and a supply of Lessons. Then let this leader call a meeting at the Grange Hall or the school house, or at his home. State the objects of the meeting. Distribute and examine the lessons. Discuss matters informally and then take the

names and addresses of all those who wish to become members of the Reading-Course, and forward them to us promptly. When the Lessons are received from us arrange to meet regularly once a fortnight throughout the winter. Meet oftener if you wish, but intervals of more than two weeks between meetings are usually undesirable. Not less than two meetings should be devoted to each lesson. Thresh out the whole subject thoroughly. Do not run it over superficially. Conscientious criticism and courteous disagreement are much better than carelessness and indifference. Remember that our main object is to help the farmer to a better understanding of the underlying principles of his calling. There are no fees and no dues. The expense of this work is provided for by State appropriation under the provisions of the Agricultural Extension (Nixon) bill.

The Farmers' Reading-Course enterprise divides itself into three parts:

1. *Reading.* Organization of clubs. Lectures before these clubs by members of the Cornell College of Agriculture. Mutual correspondence and help. There are now three series of reading, either one or all of which may be taken up by the club:

  A. The soil and fertility; plant growth

  B. Dairying and stock feeding.

  C. Fruit growing.

2. *Experimenting.* When a Club finds that there is some serious agricultural difficulty in its region, arrangements may be made for field experiments on the subject during the summer season. Special attention is now called to a circular on coöperative experiments being carried on with field crops and commercial fertilizers.

3. *Winter-Course teaching.* Beginning early in January, a winter-course of 11 weeks will be given by the University Extension Staff of the College of Agriculture. This course is designed to meet the needs of the busy farmer's son. A circular giving explicit information regarding this course may be had on application.

JOHN CRAIG,

Professor of University Extension and
Supervisor of Farmers' Reading-Course.

ITHACA, N. Y., *Nov*, 6, 1900.

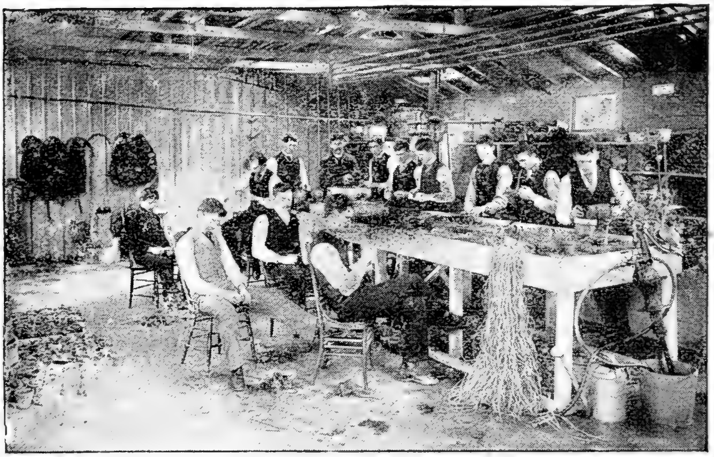
UNIVERSITY EXTENSION DEPARTMENT.

Comprises:

WINTER COURSE IN AGRICULTURE.
FARMERS' READING-COURSE.
BUREAU OF NATURE-STUDY.

PUBLICATIONS OF THIS DEPARTMENT:

FARMERS' READING-COURSE LESSONS.
NATURE-STUDY QUARTERLY.
JUNIOR NATURALIST'S MONTHLY.



Laboratory work in Horticulture. How fruit trees are made by root-grafting.

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ALICE G. McCLOSKEY, Junior Naturalist.

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